

JANUARY 1957

Research & Engineering

gin.

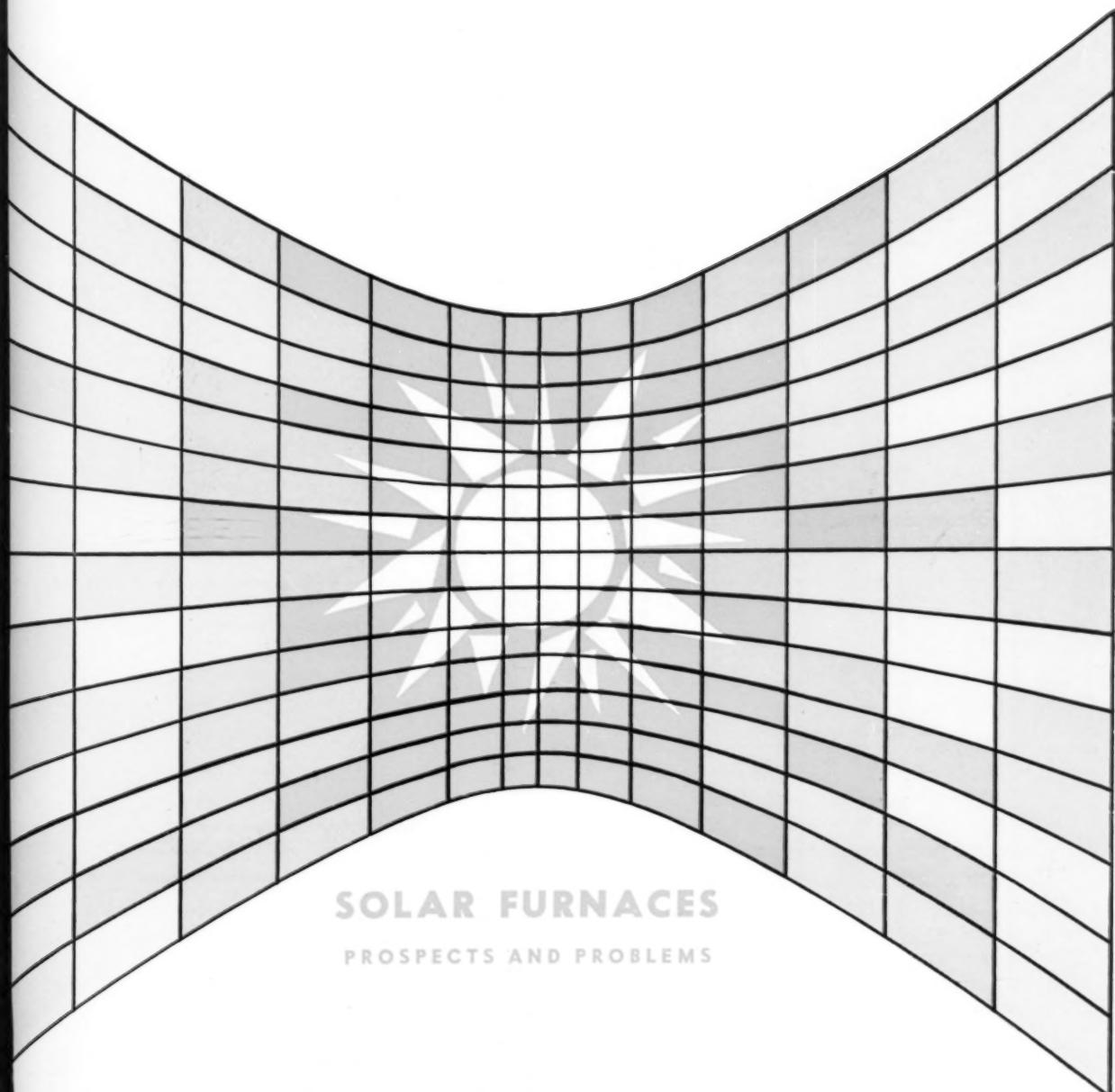
for MANAGERS of research design and development

163
3
0.2

UNIVERSITY
OF MICHIGAN

APR 30 1957

ENGINEERING
LIBRARY



SOLAR FURNACES

PROSPECTS AND PROBLEMS

au-to-má-tion

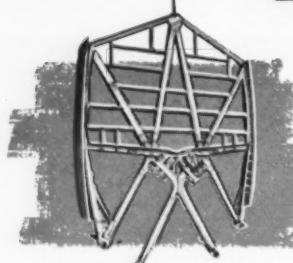
STRETCHING THE EXECUTIVE HOUR

ORGANIZING FOR EFFECTIVE R/D

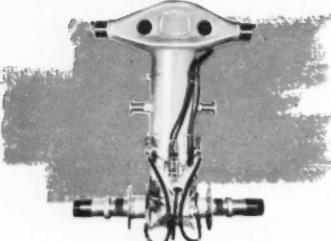
FACE TO FACE: R/E INTERVIEWS KINZEL OF CARBIDE



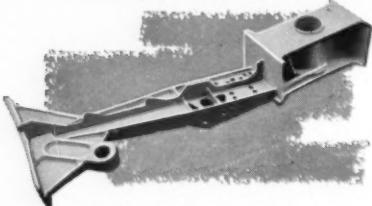
Jet engine spacer ring



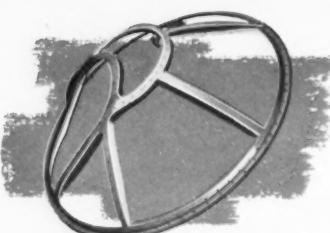
Bulkhead



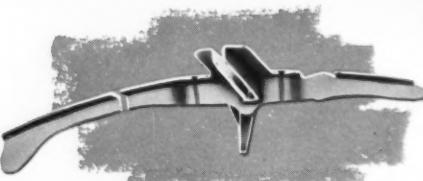
Landing gear assembly



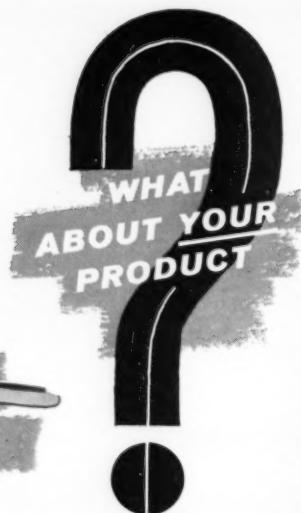
Stabilizer hinge support



Bomber nose



Inboard strut for airframe assembly



Save up to 70% on material costs **CUT** machining costs by 50%

Put your complex components in the hands of A. O. Smith! Exclusive E.D.O.S. manufacturing process is faster than conventional methods . . . assures a stronger product . . . cuts your costs.

For example, a conventional titanium rough-forged jet engine ring, 17½" O.D. x 5½" wide, weighs 70 pounds — while its counterpart, an E.D.O.S. precision-forged, contour-rolled titanium ring, weighs but 20 pounds! Save 71% on material . . . 50% on machining time.



WRITE TODAY FOR FREE ILLUSTRATED BOOKLET — Bulletin 1-17A — Complete with technical details. Also arrange for showing of new 16-mm. sound color movie about this remarkable process.

A.O. Smith does it for you

with



Engineered Designs for Optimum Structures

This remarkable metal- and work-saving process is ideal for titanium, steel and other heat-resistant alloys . . . may be the answer for fabricating your product. For further details about E.D.O.S., contact A. O. Smith Corporation, Milwaukee 1, Wisconsin.

Through research  . . . a better way

A.O.Smith
CORPORATION
MILWAUKEE 1, WISCONSIN

International Division: MILWAUKEE 1, WISCONSIN

FOR MORE INFORMATION CIRCLE 1 ON PAGE 48

Research & Engineering

for MANAGERS of research design and development



Solar Furnaces: Prospects and Problems

FEBRUARY 1957 VOL. III No. 2

Lawrence Sandek 8

Solar batteries and nuclear power have dominated our thinking about new energy sources. But solar furnaces have come a long way too.

Stretching the Executive Hour

Louis J. A. Villalon 12

Pressure and the desire to meet it can turn you into a human dynamo. Learning a few tricks can make you a relaxed human dynamo.

Auto-mation George and Paul Amber 20

The word has become an ad-man's hyperbole, and its misuse has divested it of meaning. The brothers Amber try a redefinition.

Organizing for Effective R/D

Robert K. Stolz 28

How to alleviate R/D growing pains.

Technical Management: Professional Status 3

Upgrading technicians is one answer to the engineer shortage. But there are concomitant problems. Dr. Williamson examines some.

Face to Face: R/E Interviews Kinzel of Carbide 16

A guided tour through the research policies of one of America's billion-dollar corporations.

The Other Side of the Atom 41

By concentrating on the atom as a power-source, we are neglecting its other possibilities—heat, for instance.

Letters	6	Components	40
Yardsticks	26	Laboratory Equipment	42
R/D Contracts	32	Materials	45
Books	36	Advertising Index	46

PUBLISHING STAFF:

William H. Relyea, Jr., Publisher
Walter L. Benz, Publishing Manager

ART DIRECTION:

Robert and Jack Strimban

EDITORIAL STAFF:

Melvin Mandell, Editor
Scott Nicholson, Associate Editor
Lawrence Sandek, Associate Editor
Luis J. A. Villalon, Management Affairs Editor
Dr. Merritt A. Williamson, Contributing Editor
Dr. R. C. Vickery, Contributing Editor

RESEARCH & ENGINEERING IS CIRCULATED TO MEN IN CHARGE OF INDUSTRIAL RESEARCH, DEVELOPMENT AND DESIGN DEPARTMENTS IN ALL BRANCHES OF INDUSTRY AND IN GOVERNMENT RESEARCH INSTALLATIONS. SUBSCRIPTION: U. S. AND CANADA, \$10.00 ANNUALLY; OTHER COUNTRIES, \$30.00 ANNUALLY; SINGLE ISSUE, \$1.00 WHEN AVAILABLE. PUBLISHED MONTHLY BY THE RELTEA PUBLISHING CORPORATION. WILLIAM H. RELYEAE, JR., PRESIDENT; EXECUTIVE, ADVERTISING AND SUBSCRIPTION OFFICE: 103 PARK AVE., NEW YORK 17, N.Y. LE 2-0541. EDITORIAL OFFICE: 77 SOUTH STREET, STAMFORD, CONN., FIRESIDE 8-7781. UNSOLICITED MANUSCRIPTS MUST BE ACCOMPANIED BY RETURN POSTAGE. ALTHOUGH ALL REASONABLE CARE WILL BE TAKEN, THE EDITORS ASSUME NO RESPONSIBILITY FOR THEIR SAFETY OR RETURN. ALL EDITORIAL COMMUNICATIONS SHOULD BE SENT TO THE STAMFORD OFFICE. PUBLISHED AND ACCEPTED AS CONTROLLED CIRCULATION PUBLICATION AT ORANGE, CONN. COPYRIGHT 1957, THE RELTEA PUBLISHING CORP. THE TRADEMARKS R/E AND RESEARCH & ENGINEERING ARE THE PROPERTY OF THE RELTEA PUBLISHING CORP., REGISTERED WITH THE U. S. PATENT OFFICE.

BPA

OVER 28,000 SUBSCRIBERS



One of these oscilloscopes may belong in YOUR picture

If an oscilloscope with the right characteristics will help speed progress in your work, you'll be interested in the performance range covered by these ten Tektronix Oscilloscopes. Each has been designed for a particular application, from the compact Type 310 Portable Oscilloscope to the Type 517A, specialized for high-speed pulse analysis. Each of the five oscilloscopes designed to work with interchangeable plug-in preamplifiers offers an extremely high degree of versatility in a single instrument.

Your complete oscilloscope requirement may be satisfied by one of the more versatile instruments. Or, you may have an unusual requirement that can be satisfied only by a highly-specialized oscilloscope. In selecting the right oscilloscope for your present and future needs, a consultation with your Tektronix Field Engineer can be very helpful. It's a matter of great importance to him that you make the best possible selection, because his term of responsibility parallels the useful life of your Tektronix instrument...and that's a huge chunk of his future.

Tektronix, Inc.

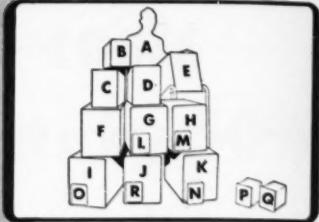
P. O. Box 831 • Portland 7, Oregon

Phone CYPRESS 2-2611 • TWX-PD 265 • Cable: TEKTRONIX

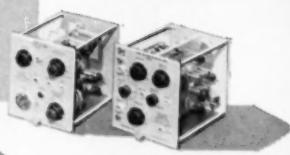
ENGINEERS—interested in furthering the advancement of the oscilloscope? We have openings for men with creative design ability. Please write to Richard Ropiequet, Vice President, Engineering.

FOR MORE INFORMATION CIRCLE 2 ON PAGE 48

- A. Tektronix Field Engineer.
- B. Type 310 Oscilloscope, 3" portable, dc to 4 mc, weight only 23½ lbs. Price \$595.
- C. Type 315D Oscilloscope, 3" portable, dc to 5 mc, weight only 36 lbs. Price \$770. Rack-mounting model also available.



- D. Type 515 Oscilloscope, 5" portable, dc to 15 mc. Weight only 40 lbs. Price \$750.
- E. Type 517A High-Speed Pulse Oscilloscope. Seven-millimicrosecond risetime, 24 kv accelerating potential. Price \$3500.
- F. Type 524AD Television Oscilloscope. DC to 10 mc, 0 to 25 millisecond sweep delay. Price \$1180.
- G, H, I, J, K. Oscilloscopes using plug-in preamplifiers. Seven Plug-in Units available. Extra wide sweep range. Extreme versatility.



- L. Type 531 Oscilloscope. DC to 10 mc, 10 kv accelerating potential. Price, without plug-in units, \$995.
- H. Type 535 Oscilloscope. DC to 10 mc, 10 kv accelerating potential, 1 µsec to 0.1 sec sweep delay. Price, without plug-in units, \$1300.
- I. Type 532 Oscilloscope. DC to 5 mc, 4 kv accelerating potential, 8-cm linear vertical deflection. Price, without plug-in units, \$825.
- J. Type 541 Oscilloscope. DC to 30 mc, 10 kv accelerating potential. Price, without plug-in units, \$1145.
- K. Type 545 Oscilloscope. DC to 30 mc, 10 kv accelerating potential, 1 µsec to 0.1 sec sweep delay. Price, without plug-in units, \$1450.

PLUG-IN UNITS

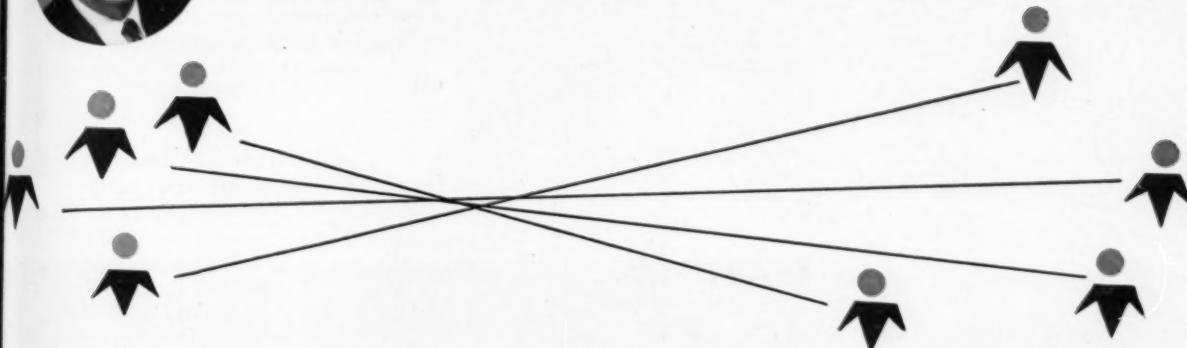
- L. Type 53/54A Wide-Band DC \$85
- M. Type 53/54B Wide-Band High-Gain 125
- N. Type 53/54C Dual Trace Fast-Rise DC 275
- O. Type 53/54D Differential High-Gain DC 145
- P. Type 53/54E Differential Low-Level AC 165
- Q. Type 53/54G Differential Wide-Band DC 175
- R. Type 53/54K Fast-Rise DC. 125

All prices f.o.b. Portland, Oregon



TECHNICAL MANAGEMENT

MERRITT A. WILLIAMSON



"I dedicate myself to the dissemination of engineering knowledge and especially to the instruction of younger members of my profession in all its arts and traditions".

This statement appears in the document entitled "Faith of the Engineer" published by the Engineer's Council for Professional Development. Since President Eisenhower has proclaimed February 17-23 as National Engineers' Week, I thought it might be well to discuss the problem of professional personnel development.

Surveys tell us that much of our trouble in R/D stems from a lack of recognition or appreciation of the worker. Engineers are no different from any other workers in their need for praise and understanding. Above all, they must feel that they're moving ahead—that their abilities are being recognized and rewarded. Their rate of progress must give evidence of the fact. This is especially important with respect to technicians, who are not engineers now but who may be some day.

Problems of Upgrading Technicians

In this day of tremendous demand for engineers there is constant pressure to promote sub-standard men into higher categories. This should be resisted because it does not further the profession, and, I believe, will ultimately work to the detriment of the man who gets put ahead of his abilities.

Upgrading technicians to the level of engineer also runs up against the resistance of certified engineers, some of whom resent having the title of engineer given out indiscriminately. They prize it highly, which is only right. They've invested a lot of sweat and cash in the piece of paper which is called a diploma. They don't like to see others acquire the same title without having earned it.

To my mind, however, "engineering" is not necessarily confined to graduates of formal engineering curricula. It is more an approach to problems—a methodology. I have known some men with no degrees who are better engineers than many who hold advanced degrees. Is it fair to deny a title and possibilities for promotion to men employed on engineering work just because they never received a degree?

I feel that promoting of technicians to engineers should be encouraged, but it should be done properly. In other words, does your promotion policy recognize real engineering ability or is it only a means of holding on to good technicians?

Finding accurate criteria by which to appraise men's

promotability is central to this whole problem of appreciation—recognition. That's why this month I would like to discuss these criteria. Lately, many promotion questions are being decided by review boards comprised of senior engineers; so I'll address myself to them.

The Working Record

The committee members should meet and examine the man's complete record. They should obtain statements from his engineering associates indicating that he is acceptable to them as an equal. They should arrange an oral examination to satisfy themselves that his knowledge of his field is up to standard. They should also carefully observe his approach to the solution of problems.

But in receiving testimonials, the review board should be cautious of this point: If one is close enough to a person to be competent to judge, then he is also close enough to be biased. From this position it may be difficult to see the applicant as he really is, and make a fair evaluation.

Passing The State Boards

If the technician passes the committee's review, the company should pay for his taking the Engineer-in-Training examination that is posed by the state. Perhaps because I am a registered professional engineer, I naturally lean toward a state-prescribed professional examination. It is designed to test knowledge of engineering fundamentals. Passing it successfully is a proof as far as the state is concerned that the individual has a background equivalent to a graduate from an approved engineering school. I think every person should demonstrate this background before he is given an engineering classification. Just because he is extremely well informed in a narrow area of technology is by no means an indication that he deserves to be called an engineer.

He can, if he wants, follow up the Engineer-in-Training examination by taking, at a later date, the full examination and receive his certification as a registered engineer. Many localities offer courses designed as a review for the examination. If he passes an examination at the advanced level, then, it seems certain that he really is an engineer and no one should deny him this classification. If he fails to pass the Engineer-in-Training examination, then the board has definite and unbiased data on which to turn down the request, but I feel that this should be the final filtering operation.

(Continued on page 34)

EXPLORING

NEW

TERRITORY?

Hydroxylamine salts*

may apply

in your field

For synthesis—

Hydroxylamine salts may be used to make oximes, hydroxamic acids, and numerous intermediates.

They are useful for preparation of anti-skinning agents, anti-rusting agents, and pharmaceuticals.

As acid-stable reducing agents—

For metallic ions such as ferric, cupric, silver, and for nonmetallics such as dyes, peroxides, and nitrites. These compounds are useful in purification processes, dyeing of acrylic fibers and as a shortstopper for catalyzed polymerization reactions.

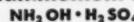
As oxidizing agents—

This is new territory that needs exploring. Hydroxylamine salts are probably mild oxidizing agents.

Effects on proteins and biological systems—

Hydroxylamine salts inhibit enzymes such as catalase, harden gelatine . . . derivatives are good fungicides and bactericides. For the most part, this is a poorly explored area suitable for intensive experimentation.

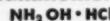
*Hydroxylammonium Acid Sulfate



Hydroxylammonium Sulfate



Hydroxylammonium Chloride



Already known for their wide range of utility, these nitroparaffin derivatives may find dramatic uses from future research. Their potential applications for experimentation are almost unlimited.

For more details on these and other uses for Hydroxylamine salts, mail the coupon below.

COMMERCIAL SOLVENTS CORPORATION

Industrial Chemicals Department • 260 Madison Ave. • New York 16, N. Y.

Please send me data sheets #19 and #19A for information on Hydroxylamine salts.

Name _____ Title _____

Company _____

Street _____

City _____ Zone _____ State _____



FOR MORE INFORMATION CIRCLE 3 ON PAGE 48

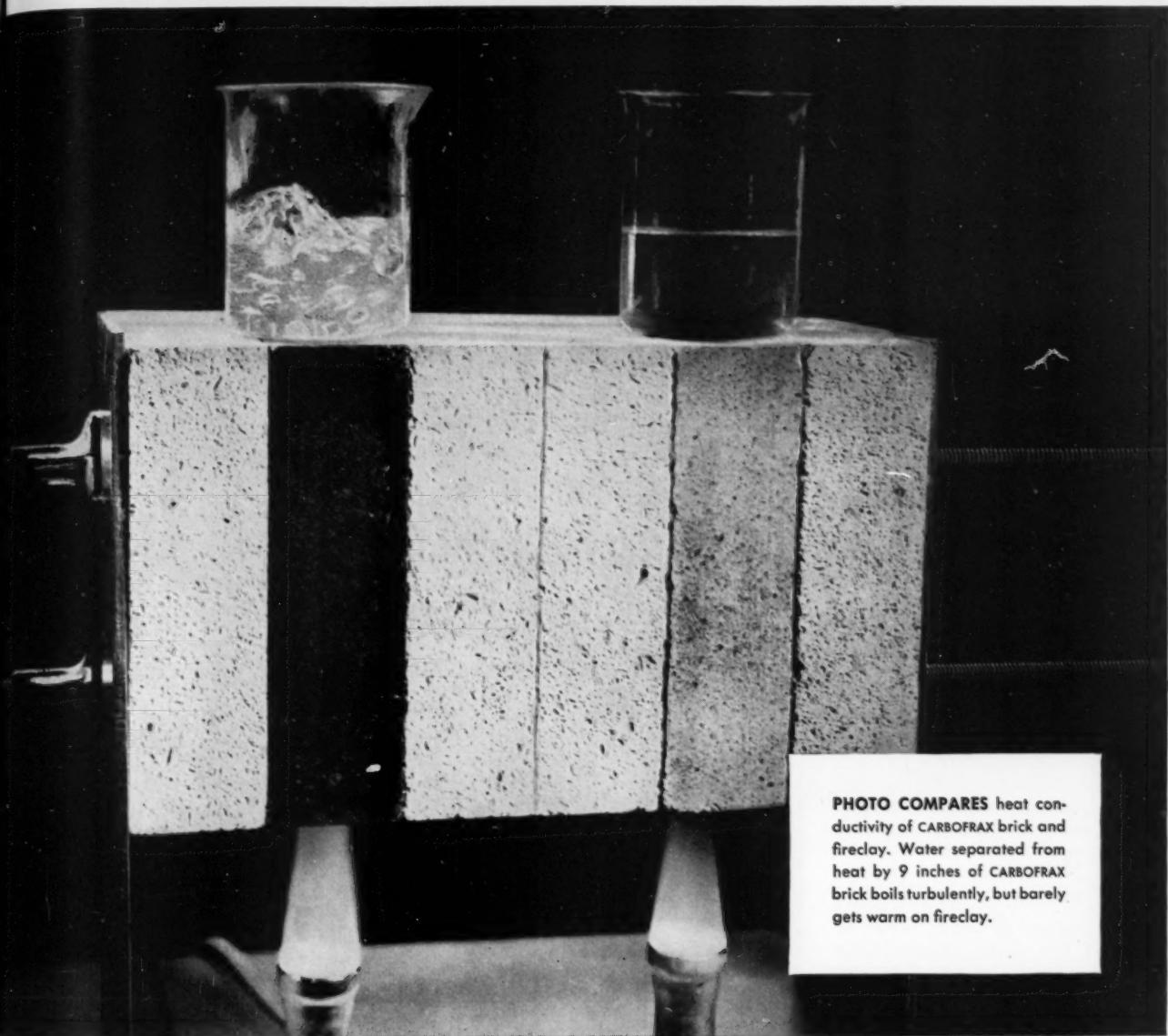


PHOTO COMPARES heat conductivity of CARBOFRAX brick and fireclay. Water separated from heat by 9 inches of CARBOFRAX brick boils turbulently, but barely gets warm on fireclay.

Refractories - for high heat conductivity

High heat conductivity—roughly 11 times that of fireclay and about 70% that of chrome-nickel steels—is one of the properties of CARBOFRAX® silicon carbide refractories. It is an ideal material for muffles, radiant tubes, retorts and similar structures where you need exceptional resistance to direct flame plus the ability to conduct heat efficiently. At 2200°F, thermal conductivity of CARBOFRAX brick is 109BTU/hr., sq. ft. and °F/in. of thickness.

CARBOFRAX refractories typify the many super refractories pioneered by Carborundum. Each has a wide range of properties. One, for example, is formed into precision parts that look like cast iron yet resist over 3000°F. Another, a new ceramic fiber, filters and insulates at temperatures no existing mineral or glass fiber can take.

For valuable information about high temperature problems—and other pertinent information about refractories—or for help on your own particular problem—fill in and mail this coupon today:

----- MAIL THIS COUPON TODAY -----

Refractories Division,
The Carborundum Company, Perth Amboy, N. J., Dept. S 27

Please send me:

- Forthcoming issue of Refractories Magazine
- Bulletin on Properties of Carborundum's Super Refractories
- Here is a description of my high temperature problem.
Can you help me?

Name _____ Title _____

Company _____

Street _____

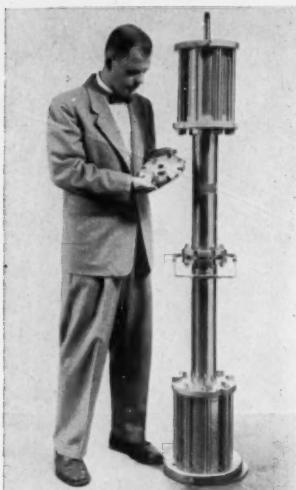
City _____ Zone _____ State _____

CARBORUNDUM

Registered Trade Mark

FOR MORE INFORMATION CIRCLE 4 ON PAGE 48

Now you can shock test with a controlled 10,000-pound thrust



Using the HYGE shock tester, you can simulate actual service conditions to test the shock resistance of parts and assemblies.

You can set up the HYGE to produce specific acceleration and/or deceleration wave forms for desired durations.

Theoretically, the HYGE can produce a maximum build-up rate of 200,000 g's per second from zero to peak acceleration. The acceleration pattern is free of high-frequency transients.

◀ The HYGE shock tester, manufactured and marketed by CEC under license from the Convair Division of General Dynamics Corporation.

How the HYGE Shock Tester works

Essentially a free floating piston in a closed cylinder, the HYGE gets its punch as the result of differential pressures on the two faces of its thrust piston. (See diagram.)

A low pressure in the top gas chamber forces the piston against a seal ring which seats on top of the orifice. Only the small piston area exposed to the orifice is open to pressure from the lower chambers.

By introducing compressed nitrogen into the lower chamber, you can equalize the forces on the two faces of the piston. Just a slight increase in pressure upsets this equilibrium, moves the piston up slightly, breaks the seal at the orifice, exposes the entire bottom of the piston to the high pressure of the lower chambers, and shoots the piston up with a terrific thrust.

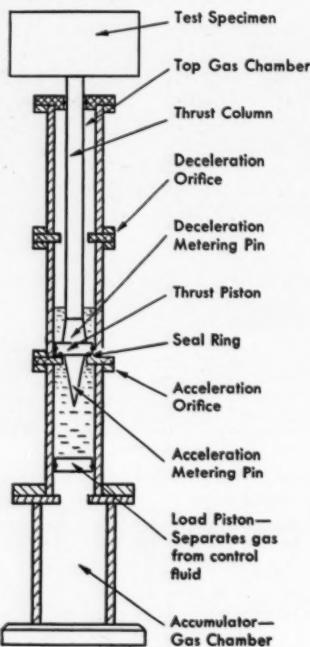
Theoretically, the thrust will equal the difference in pressure between the upper and lower chambers times the net piston area exposed. This thrust is transmitted directly to the test specimen through a column.

The shape of the metering pin at the base of the piston regulates acceleration. Metering pins of different shapes produce different shock patterns.

To get controlled deceleration, add an orifice above the piston and another metering pin.

Several standard types of HYGE shock testers are available. There is also a "kit" of modular components from which a variety of units can be developed. Units can be combined to develop enough thrust for large test specimens.

Send for Bulletin P4-70 for a more detailed discussion of the HYGE shock tester.



Consolidated Electrodynamics
Rochester Division, Rochester 3, N. Y.

formerly Consolidated Vacuum

NATIONWIDE COMPANY-OWNED SALES AND SERVICE OFFICES

FOR MORE INFORMATION CIRCLE 4 ON PAGE 48



Letters

Please send all letters to the editor to our editorial offices, 77 South St., Stamford, Conn.

MORE ON LEAKPROOF SEALS

Bayside, L.I., N.Y.

I have enjoyed reading R/E for some time and have found some of your articles extremely interesting. In your October 1956 issue the article by Messrs. Lobo and Slepcevich (High-Pressure High Temperature Chemical Reactors) interested me a great deal. The article explains the pros and cons of several types of leak proof seals.

The writers' interest appears to be a yen for a leak proof seal which can be dismantled and assembled readily. They should read the "The Knife Edge Seal" in the Vacuum Symposium Transaction for 1955.

We have used the seal in a great deal of our vacuum tube testing work. We have made seals of $\frac{1}{4}$ " to 12" in diameter and have used other materials beside metals. Our temperature range has been from -186°C to 450°C . I cannot see any reason why it should stop at 450°C if the proper materials were chosen.

The seals have withstood many bake outs, at 450°C , without leaks developing. We have had failure of the vacuum system components more often than the seals. The seals have been used on vacuum tubes where the pressure is 1.0×10^{-11} mm Hg.

JOSEPH M. LECH, Sr. Tech.,
SYLVANIA ELECTRIC PRODUCTS, INC.

THEY'RE TOO HEALTHY!

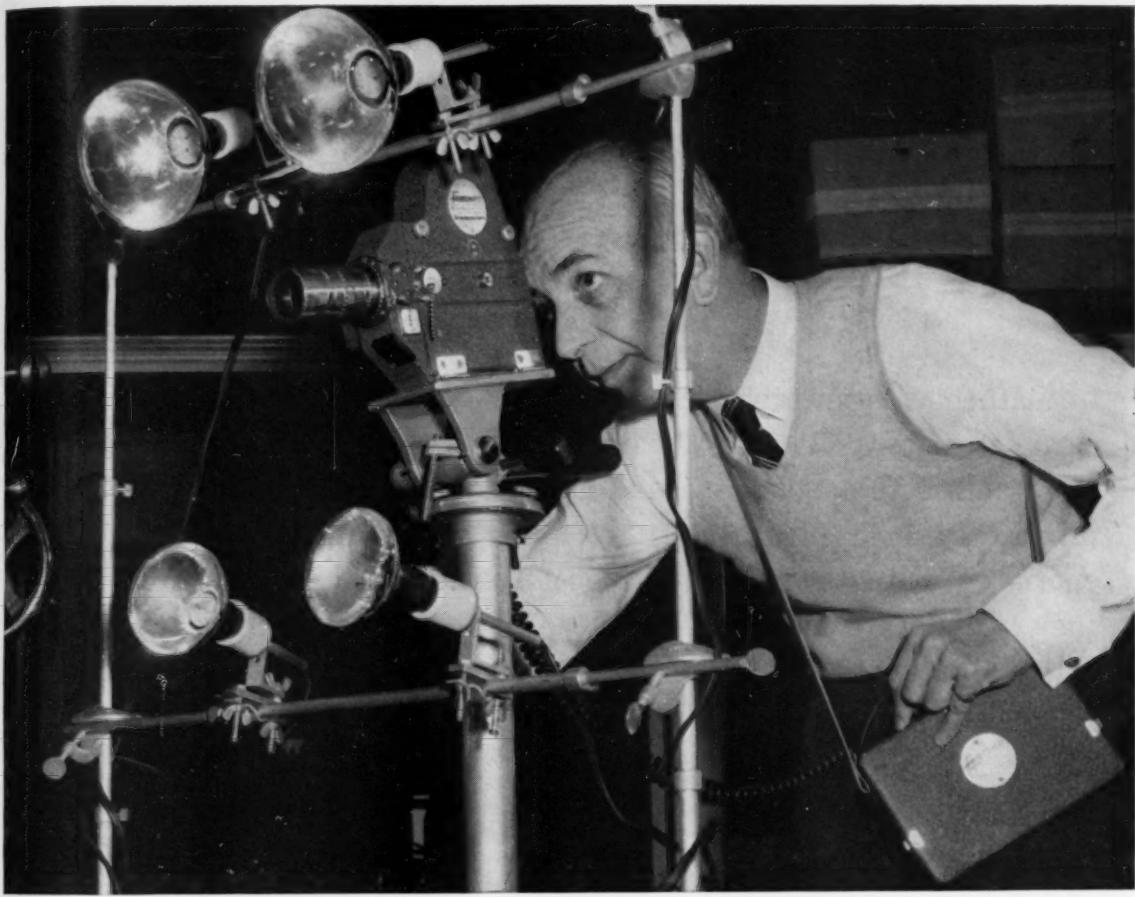
Vineland, N.J.

Your magazine has had several articles on R/D administration of interest to me, especially the fine article "How Much Is an R/D Boss Worth?" I wonder if you would care to answer a question for me?

There are many talented men pigeonholed in companies where there is no room for promotion because top management is already staffed with healthy, capable managers. Do you know of any reputable counseling service to help such engineers through the steps to top management; to help them determine reasonable goals for their abilities; and to steer them toward the jobs where their abilities count most?

(NAME WITHHELD BY REQUEST)

In the coming months R/E will feature two articles which answer these and other questions about opportunities to advance in the field of research and development.—Ed.



32 to 8,000 pictures per second with the newest high-speed motion picture camera

The Fairchild Motion Analysis Camera System, completely light-weight and portable, designed with the aid of the men in the field for today's instrumentation and research needs. The Fairchild MAC features:

- A 10 lb. camera, suitable for handholding.
- A 4½ lb. field power supply, smaller than a cigar box.
- Camera and event synchronizer (a-c or d-c), the size of a large briefcase.
- A tripod that folds down to a length of 16".
- Lighting equipment, minimal size, portable.
- A complete family of ruggedized lenses from 3.7 to 254 mm and auxiliary optical equipment which includes fiducial markers and means for making combined oscillographic and high-speed motion pictures.

Performance:

- The widest speed range available, covered with easily interchangeable motors.
- Unrivalled picture steadiness and sharpness.
- Stop-start operation up to 450 pps.
- Capable of withstanding severe environments of vibration, acceleration or shock.

- Color film without color correction filters.
- Simplest loading and operation.

Cost:

- The camera with any lens from 13 to 154 mm. focal length and any motor is only \$1,190.00.

For full information on the camera and complete system plus latest data on high speed photography, mail coupon today:

**Free Quarterly Newsletter
"WHAT'S GOING ON IN PHOTOGRAPHIC INSTRUMENTATION?"**

Fairchild Camera & Instrument Corporation
Photographic Instrumentation Department
88-06 Van Wyck Expressway, Jamaica 1, N. Y., Dept. 130-2A.

Please send me full information on MAC and include your free newsletter "What's going on in high speed photography?".

Name _____ Title _____

Firm _____

Street _____

City _____ Zone _____ State _____

FAIRCHILD
CAMERA AND INSTRUMENT
CORPORATION

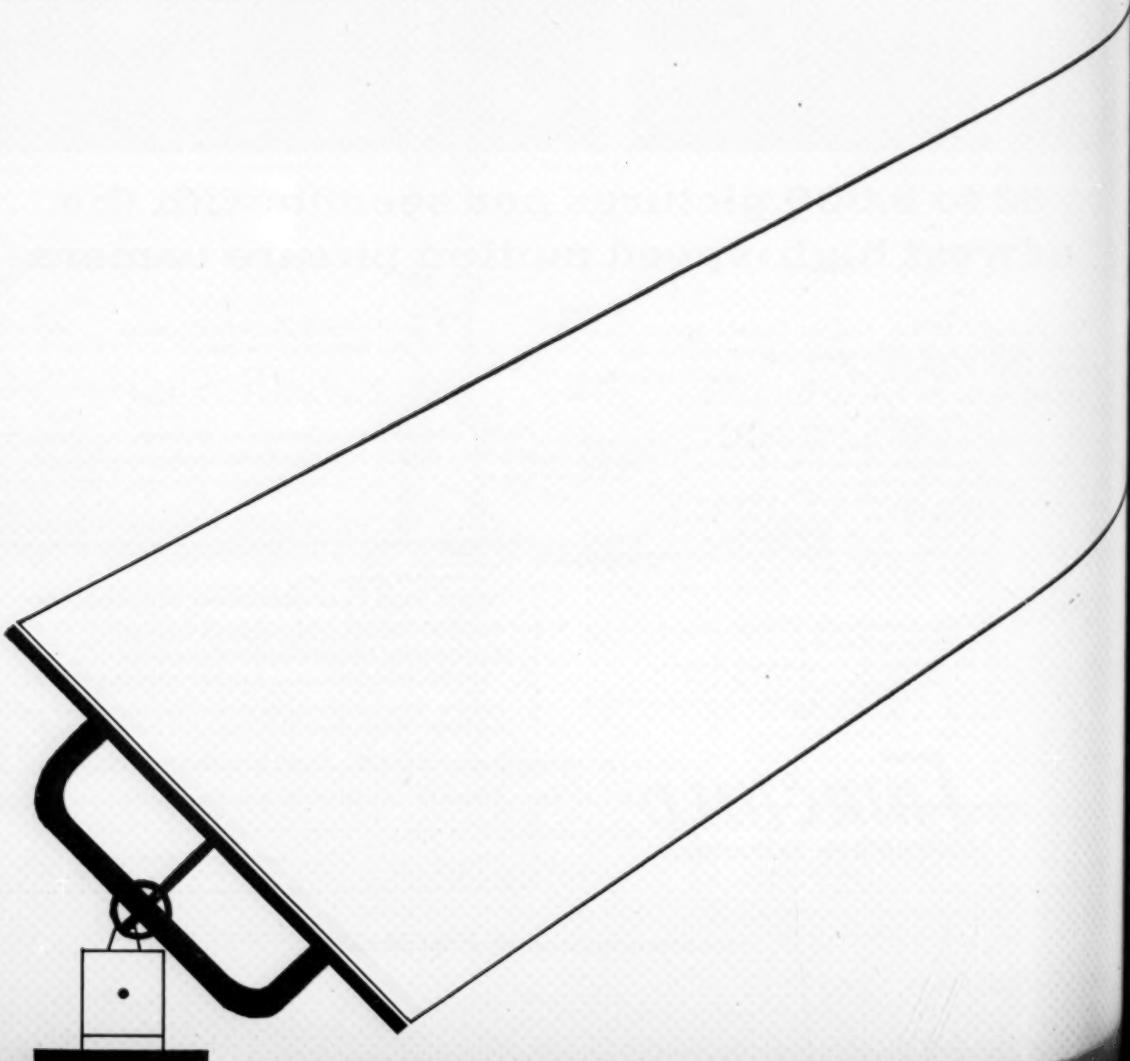
FOR MORE INFORMATION CIRCLE 5 ON PAGE 48

SOLAR FURNACES

PROBLEMS & PROSPECTS

LAWRENCE SANDEK, associate editor

In mathematics, metaphysics, and science, simplicity is part of the elegance of any solution. Much of simplicity consists in eliminating more and more parts or steps. This is the fascination beyond the promise of solar furnaces. They offer a means of using the sun's enormous output directly; dispensing with mediate steps—fossil fuels, wind, water power. What is the future for solar furnaces? What is their present state of development? Here is a brief survey of the promise they offer and the problems they present.



This is the 2,169th anniversary of history's most dramatic use of concentrated sunlight. For in 212 B.C., legend has it, Archimedes helped Syracuse fend off an invading fleet by setting fire to its sails. He used a diabolical arrangement of small mirrors that focused the sun's rays upon the Roman target several hundred yards away.

Pliny in the first century of the Christian era wrote of solar burning glasses used for cauterizing wounds. And in 1774—183 years ago—Lavoisier, the father of modern chemistry, attained temperatures in the neighborhood of 3200°F with a large double-lens solar furnace. With it, he demonstrated the carboniferous nature of diamond and almost melted platinum.

But it has not been until the past decade or so that the splendid madness of trying to harness the sun has moved a significant number of workers in modern science to carry on the work begun by Archimedes and Lavoisier. The prize: 85 trillion kilowatts of energy that annually reach the earth's surface. Share for the U.S.: the equivalent of 1150 billion tons of coal. Which means that the energy radiated upon the United States by the sun in a single year exceeds by about 10 percent all of the energy locked in our estimated recoverable coal reserves.

At the Solar Furnace Symposium held under the auspices of the Association for Applied Solar Energy in Phoenix, Arizona, last month, solar furnace design, its problems and prospects, was brought still further out of the realm of legend and into modern technology.

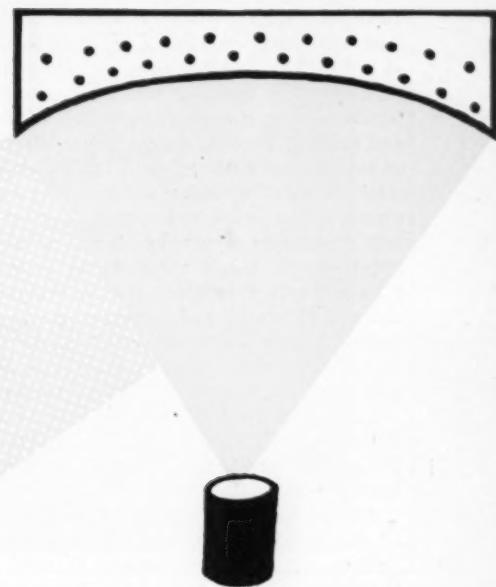
Work on solar furnaces has thus far produced research models capable of generating up to 3300°K, but these temperatures are in small areas at the focus of the paraboloidal reflectors. The U.S. Army's Quartermaster R/D Command is planning a solar furnace that will yield an image size (effective heating area) in the neighborhood of five inches. And though this is sufficient for their purposes of researching protective measures against thermal radiation from nuclear sources, it is scarcely adequate for industrial applications like power.

Using solar energy presents other problems. It reaches us in the form of electromagnetic radiation—nearly half as visible light, a small amount as ultra-violet, and only half as infrared, or heat. And though that remaining half may represent an enormous total energy, it is not very concentrated, nor in the most convenient form—electricity. The problem of converting solar heat to electricity in industrial quantities is a very great one.

When these problems have been solved—when we have concentrated solar radiation from its low potential and transmuted it into the form we want—there will yet remain the problem of storage. The sun shines intermittently but we need continuous power: how can we store solar energy for use at night or on cloudy days?

Contamination-Free Heat

The most promising aspect of solar furnaces, and the one that most assures continued financial support for furnace research, is the high temperatures they can attain and the conditions under which they attain them. Dr. Peter Glaser of Arthur D. Little, Inc., argues that the solar furnace offers ideal research conditions. Solar radiation is a pure source of energy without objectionable by-products of combustion. The material to be heated in the furnace is its own container, thus another source of possible contamination—the materials of the



furnace itself—is eliminated. No insulation is needed for the furnace because it remains virtually at atmospheric temperature. In addition to the high temperature and pure source advantages, the solar furnace offers an accurately controllable heat flux, and comparative facility in manipulating the work.

These are substantially the considerations that moved the Kennecott Research Center into building a solar furnace. Much of their work involves molybdenum, rhenium, and niobium; all of which metals require special purification and fabrication techniques because of their high melting points and their affinity for oxygen and nitrogen. Additional considerations that recommended the solar furnace are its ability to fuse samples without contamination from the container and the adaptability of the furnace to different types of problems. Kennecott used their furnace for, among other things, zone refining.

Two-Mirror Combination Most Common

Most solar furnaces now planned employ a two-mirror paraboloid-heliostat combination. The heliostat catches the incident rays of the sun and directs them to the paraboloid reflector where they are concentrated onto the furnace located at the reflector's focus.

Much of furnace research is concerned with the efficiency of the reflectors.

Ralph H. Wight of Pittsburgh's F. W. Fecker Corporation in his paper, *Materiels and Surfaces for Solar Furnaces*, divides reflector research into two main groups: the reflecting surfaces themselves and the material of which they are made; and the approximation to perfection of the paraboloidal surface.

In small furnaces, a single-piece metal or glass paraboloid is feasible, as witness the furnaces constructed of surplus search-lights. But if the furnace is to be of a size requiring a reflector of other than this standard size, the cost of a master mold would be prohibitive.

The most obvious alternative is a mosaic arrangement of elements in an approximately paraboloidal configura-

tion. Mr. Wight enumerates five methods of making an approximately paraboloidal mosaic.

First is to clamp and bend thin flat-glass mirrors to an approximation of the curvature desired. The second method is to approximate the paraboloid with a series of spherically ground mirrors. Toroidally ground mirrors, a third method, can more closely approach the parabola than the small spherical segments of the second method. Fourth, slumping flat glass into a spherical or toroidal approximation of the paraboloid. And fifth, a combination of slumping and grinding and polishing techniques might be evolved so that no great amount of glass will have to be removed in grinding and polishing. The latter method would result in an appreciable saving of time and effort as compared to grinding and polishing alone, and would yield greater surface accuracy than precision slumping alone. Still to be more thoroughly explored are metal-coated reflectors of reinforced plastic. Experimental models 3' OD have already been cast.

Quite aside from technical considerations, costs impose their limits on solar furnace design. Raymond W. Bliss, Jr. of Donovan & Bliss, Amado, Arizona, offers the following argument.

Assume preliminary tests show that a furnace factor of 0.5 has been attained. (The furnace factor is the product of all transmissivity factors allowing for all theoretically avoidable energy losses in transit through the furnace apparatus.) A furnace having a concentration ratio of 10,000 and a hot spot diameter of 2 inches requires a bowl area of 600 square feet. Such a furnace could produce maximum temperatures around 3400°C. Now, if we want to double the concentration ratio and spot diameter, the bowl requirement will be 8000 square

feet—14 times the bowl area of the first example. But the greater size would produce only an additional 600°. And the 14-times increase of bowl size suggests that there would be a 14-times leap in cost. This is a formidable economic fact.

A design study of the structural and component requirements for a solar furnace capable of attaining temperatures considerably higher than 3300°K leads to a configuration something like the one suggested by Frank Edlen of duPont's Engineering Department.

The reflector would have a minimum diameter of 100 inches to provide sufficient power for melting metallurgical test coupons and for operating skull-type cavity furnaces. It would be rigidly mounted, horizontally, and faced down, thus to minimize the problem of distributing shell stresses and to permit the furnace to be constructed vertically. Reflector and mounting can be maintained at constant temperature by a circulating coolant and by enclosing for weather and wind protection. The reflector might be of one-piece construction, preferably of silvered metal or glass. It must be mounted about 50 feet above the heliostat to avoid noon shadow in summer.

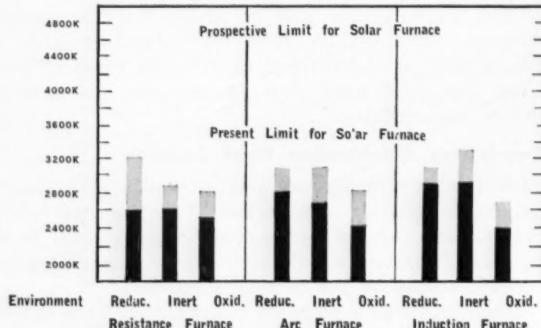
The heliostat reflecting surface would consist of optically flat glass mirrors, approximately two feet square, individually supported in a rigid frame for alignment and adjustment.

Mr. Edlin foresees the principal industrial applications for solar furnaces resulting from the solar furnace's high temperatures in contamination-free conditions. It is these characteristics, he feels, that should be exploited in designing future furnaces.

Solar furnaces probably will be used for the commercial processing of materials. Processing costs at a

Furnaces vs. Furnaces

Comparison of Electric and Solar Furnaces



Present and prospective limits for solar furnaces are here compared with the upper limits of electric furnaces (shaded zones). The indicated temperatures are attainable only in selected applications that certain contamination levels can be tolerated.

Resistance Furnaces

Electric resistance furnaces of graphite construction are limited from reaching higher temperatures by the vapor pressure of carbon and thermionic discharge from the heating element. These furnaces can be modified so that the usual reducing atmosphere can be excluded from the reaction zone by refractory liners, and inert or even oxidizing atmospheres can be maintained. Resistance

furnaces for use with inert or oxidizing atmospheres are made entirely of refractory oxides. These are limited to temperatures lower than those attainable with furnaces made of graphite. The limits are set by the properties of available refractories.

Arc Furnaces

Arc furnaces are widely used for the melting of electrically conductive materials. The *consumable electrode* arc furnace produces a melt by establishing an arc between the electrode and a bed of the same material as the electrode. The latter is contained in a cooled crucible. A skull of frozen melt is formed and maintained at the cooled wall. This method produces ingots of considerable size and exceptional purity.

The *non-consumable electrode* arc furnace is limited in application by the very few refractory materials suitable for use as electrodes. These materials must be electrically conductive, and the presence in the melt of minor amounts of contaminant from the electrode must be tolerable.

Indirect arc furnaces are those where the arc reaches to a crucible of refractory material containing the melt. These furnaces are also restricted to applications where electrically conductive refractories can be used. The melt here too is subject to environmental contamination.

Induction Furnaces

High-frequency induction or dielectric-heated electric furnaces are the usual choice for research investigations because of their cleanliness and simplicity of operation. The limitations of the materials of which they are constructed restrict applications, generally, to the temperature range of the other electric furnaces.—From *Industrial Considerations of Solar Furnaces* by Frank E. Edlin.

favo
of p
vestr
surfa
cost
solar
Th
indu
turin
tribu
extre
collc
deliv
per
and
In
to lie
to m
place

Bibl
Abet
Abb
sonia
Aldri
p. 71
Benve
Instit
Benve
vois
plied
Benve
Tool
78, 10
Bliss,
Rati
Furna
Force
Bliss,
formal
Memo
Bliss,
Solar
1, 195

The ADL Solar Furnace

Working in conjunction with Dr. Tibor Laszlo of Fordham University, Arthur D. Little, Inc., is now producing a solar furnace. It provides temperatures up to 3500°C, over a circular area of 0.6 centimeter diameter, without the problem of contamination from sample containers or furnace walls.

The basic component of the furnace is a 60-inch diameter parabolic mirror with the front reflecting surface stellite-coated. Although the irradiated area of the sample is small, it is suitable for many research uses. The area of high-temperature can be sharply defined and the desired temperature accurately controlled. Temperature and heat flux measurement can be made conveniently by inserting instruments through the viewing port at the back of the reflector.

The stage for mounting the sample is so designed that the sample can be tested in air, under vacuum, or in other atmospheres. Temperature control is by means of a shielding cylinder. Two motors permit rotation of the parabolic reflector around the horizontal and vertical axes. For control of the duration of the heating cycle, a shutter mechanism can be interposed between the sample and the sun.



favorable site should be nominal—a few cents per pound of product. Add 10 cents per pound to amortize an investment of \$150 to \$200 per square foot of reflector surface and associated machinery. This relatively high cost is justifiable where the unique advantages of the solar furnace are required for manufacturing.

The economics of solar furnaces are quite different for industrial power applications from those for manufacturing. Here the cost of power alone—and no other attributes of the furnace—is its justification. Fortunately, extremely high temperatures, and hence high quality collectors, are not required for routine power applications. Based on the equivalent fuel value of the energy delivered, a maximum reflector cost of one or two dollars per square foot, including auxiliaries, seems justified and possible.

In perspective, the future of the solar furnace seems to lie more in its continued refinement and application to manufacturing processes and research than as a replacement or supplement for our diminishing fossil fuels.

Bibliography

Abetti, G., *The Sun*. D. Van Nostrand, 1938.
Abbot, C. G., *Solar Radiation and Weather Studies*, Smithsonian Misc. Coll., Vol. 94, No. 10, 1935.
Aldrich and Hoover, *Table 809* Smithsonian Physical Tables, p. 719, 1954.
Benveniste, G., *Solar Energy Furnaces*. Stanford Research Institute, 1955.
Benveniste, G., *Burning Glasses: from Archimedes to Lavoisier*. The Sun at Work, June 1956, Association for Applied Solar Energy, Phoenix, Arizona.
Benveniste, G. & Hiester, N. K. *The Solar Furnace—New Tool for High-Temperature Work*. Mechanical Engineering, 78, 10, pp. 915-20, October 1956.
Bliss, R., *Notes on Optical Design Principles, Concentration Ratios, and Maximum Temperatures of Parabolic Solar Furnaces*. Holloman Air Development Center, Holloman Air Force Base, New Mexico, 1956.
Bliss, R. W., Jr., *Summary of Parabolic Solar Furnace Performance Design*. Holloman AFB, New Mexico. Technical Memorandum HWD TN-56-2. October 1956.
Bliss, R. W., Jr., *Notes of Performance Design of Parabolic Solar Furnaces*. J. Solar Energy Science & Engineering. 1, 1, 1957.

Cabannes, F., & Le Phat Vinh, A., *Calcul de la Repartition de L'Energie Solaire Reflechie par un Miroir Parabolique*. J. de Physique et le Radium, 15, pp. 817-20, December 1954.
Daniels, Farrington, *Science*, Vol. 121, 28 Jan. 1955, p. 121.
Also, M. L. Ghai, *Applications of Solar Energy for Heating, Air Conditioning, and Cooking*, Solar Energy Research, Daniels and Duffie, Eds. Univ. of Wisconsin Press, Madison, 1955, pp. 63-67.
Daniels, Farrington, *The Sun's Energy*, Scientific Monthly, Vol. 82, No. 5, May 1956, pp. 247-254.
De La Rue, Tietz, & Hiester, *Economic and Design Study of Solar Furnaces*. Prepared by Stanford Research Institute for Commander, ARDC, Baltimore, Maryland. AFOSR TN-56-382. ASTIA Document AD 95818. June 21, 1956.
Farber & Davis, *Analysis of Large Aperture Parabolic Reflectors for Solar Furnaces*. Consolidated Vultee Aircraft Corporation. Report No. TRM-77, 7 p. plus 10 figs. 28 January 1954.
Hass, G., *Filmed Surfaces for Reflecting Optics*, J.O.S.A., Vol. 45, No. 11, 1955.
Loh, Duwez, Hiester & Tietz, *Theoretical Considerations on Performance Characteristics of Solar Furnaces*. Prepared by Stanford Research Institute for Commander, ARDC, Baltimore, Maryland. Technical Report No. 1. AFOSR TN-56-69. ASTIA Document AD 81521. January 16, 1956.
Lyons, Cooper, and Cotton, *Solar Furnace Design*, Report T-7, Pioneer Research Division, Quartermaster Research and Development Center, Natick, Mass., 1956.
O'Day, Marcus D., *Some New Approaches to Solar Energy Utilization* presented at ARDC Science Symposium, 8-9 Oct. 1955, Cambridge, Mass.
Pearson, G. L., *Electricity from the Sun*. Proceedings of the World Symposium on Applied Solar Energy, Phoenix, Arizona, Nov. 1-5, 1955, pp. 281-288.
Scarrott, Charles A., *Turn to the Sun*, p. 36, Research & Engineering, September, 1955.
Telkes, Maria, *Solar Thermoelectric Generators*, Solar Energy Research, pp. 137-142, Daniels and Duffie, Eds., Univ. of Wisconsin Press, Madison, 1955.
Telkes, Maria, *Distillation with Solar Energy*, Solar Energy Research, pp. 111-118.
Telkes, Maria, *Solar Distillation of Saline Water*, Science, Dec. 18, 1956, p. 1287.
Trombe, Felix, *Development of Large-Scale Solar Furnaces*, Solar Energy Research, pp. 169-171.
Trombe, F., *High Temperature Furnaces*. Proc. World Symposium on Applied Solar Energy, pp. 63-72. Stanford Research Institute, 1956.
Weather Bureau, U. S. Department of Commerce, *Climatological Data—National Summary*, (published monthly).

STRETCHING THE EXECUTIVE HOUR

LUIS J. A. VILLALON,
Management Affairs Editor

There's an old saw that advises that the best way to get a job done is to pick the busiest man in sight and assign it to him. And, like a good many old saws, there's a good deal of truth in it.

You all know the busy executive, already involved in a myriad of projects, both company and extracurricular, who seems to be able to summon up the extra time and energy for one more assignment. How does he do it? Where does he find this extra mine of energy? And, most important, is there any way for you to tap the vein, and to wring more productive work out of your own overcrowded day?

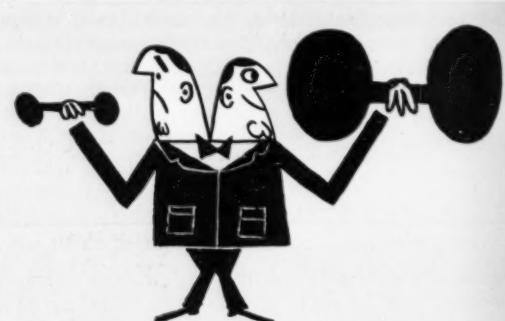
Despite "The Man in the Grey Flannel Suit" cliche, this super go-getter is not necessarily a grim, family-neglecting, fun-eschewing robot, who is driven by a ruthless single-purposed ambition. Ironically, he sometimes seems to find more time for fun than most people—and even spends more satisfying hours with his family. In learning to use time well in his work, he employs it equally fruitfully off the job.

It is not, furthermore, likely that he has any particular gift of abnormal energy. Energy is a little like another

It's entirely feasible for any one of these to better this average, if he absorbs and uses a few simple principles of performance and motivation.

Refresh Yourself by Shifting from Job to Job

One of the soundest psychological principles is that *change is rest*. Boredom is a much greater thief of productivity and efficiency than is fatigue.



Psychologists say we use only a third of our energy.

At a routine, repetitive office or factory job, research shows, loss of output and efficiency during the first four hours of work is exceedingly high.

On the other hand, at another kind of task, involving mental work designed to keep the interest level fairly constant, measured efficiency drops only about one to two percent. This is true even under uncomfortable physical conditions, such as high heat and humidity.

In the second case, interest kept the individual's energy supply constant—and kept his inbred laziness dormant. He didn't feel the need for rest until honest fatigue set in.

Laziness is a clever enemy. It causes man to confuse mental warnings like boredom and lassitude with nature's legitimate protective signals against overwork. Laziness is like an imp constantly whispering in a man's ear how



The go-getter is not necessarily a robot.

common commodity—water. If channeled and guided, it can be enormously productive. If, on the other hand, it's allowed to dribble away or flow every which way, it's practically useless. No more or less water—or energy—is needed in either case.

All our high accomplisher has done is to learn a few tricks of his trade. Research studies have been lavished on increasing the manual worker's productivity. Time and motion research, incentive studies, and investigations of the relationship of rest to work, have all been applied to the problem of increased productivity for skilled and semi-skilled workers. Knowingly or unknowingly, the successful technical manager is just applying some of the conclusions reached, plus a few psychological tricks, to his own job situation. He's increasing his personal productivity by channeling normal supplies of energy into a sustained and powerful stream.

Industrial psychologists who are working with executives in industry estimate that the average official uses only about a third to a half of his energy productively.



Laziness is an imp. Don't let it slow you down.

overworked he is, how tired he is, and how the best thing he can do is to lay off and snooze. This boredom hits long before real fatigue.

The best way to trick this imp is to recognize his

siren song as a sign merely of staleness on the particular job, and switch to another task where revived interest will sharpen up your mental processes and renew the energy that seemed to be lagging.

Some practitioners of this method actually think of themselves as moving around among a number of separate jobs—and a few do actually move around. One company vice president manages to work on his various projects in different rooms. He literally shuts the door on one problem as he goes to another. Others, without space for multiple offices, substitute sternly compartmented briefcases or different desks to escape the piled-up papers of the incomplete jobs that have been left. There are, of course, hazards in the use of this technique, but none is as hard to overcome as it sounds at first. When changing from job to job is suggested, managers inevitably ask whether they won't forget things in the process, whether their important work won't be interrupted, and whether their mind won't be left a mish-mash of incomPLETED tasks.

There is little danger of forgetting. Science has proved that memory for incompletely completed tasks, sparked by the unresolved tensions, is over 10 times as great as memory for completed ones. A good way to make the transition



The subconscious mind can do useful work.

is to end current activities with a resume or status report to oneself. This can be dictated to secretary or machine, or jotted down on a pad or paper. This procedure also helps to overcome the inertia which everyone feels to some extent when he must start a new job. Picking up your resume will tend to snap the problem back into focus, working much like the diaphragm on a preset photographic lens at the commencement of the next session.

Far from forgetting, the subconscious mind very often does useful work on a problem while the conscious mind is working on something else. No one has yet been able to chart the intricacies of the human mind, with particular reference to the subconscious, but few psychologists will deny that it does have an ability to work independently of the conscious side.

There is no need that the most important work be delayed. The objective is to get more—not less—productivity out of an individual.

One extra trick is to schedule these most important jobs into your own period of greatest work efficiency. Normally, an individual has two peaks a day for mental operations, according to tests. They are, roughly, between 10 and 11 in the morning, and 2:30 and 3:30 in the afternoon. There is, however, a wide variation among individuals, and the efficiency peaks are heavily affected by living habits—for instance by how many martinis and/or how many calories are consumed at the midday

meal. At any rate, it is not too hard to discover one's own pattern and schedule important work accordingly.

Stimulate Motivation for More Energy

The words "motor" and "motivation" derive from the same root. Motivation is, in fact, the motor that gener-



We have two peaks a day for mental operations.

ates energy. Without it, all the tricks in the world won't enable you to do more than you need to get along.

Here again, however, the superheated doer has learned to play some tricks on himself. One of them is to announce goals, projects, and ideas before they are accomplished to people whose respect you want to keep or whose opinion is important to you. Once you have given yourself a public time-limit and have made a public promise from which you cannot back out without losing face, you have created a powerful drive to live up to your commitment.

One R/D manager goes so far as to write out a policy statement of what he wants to accomplish every time



Announce goals and projects beforehand.

he starts a new job. He then asks his boss to initial it, and publicly commits himself by showing it to his department. Then his pride won't let him neglect it.

On short-term administrative projects, some extreme followers of this theory actually announce that they have completed a certain assignment and that they will deliver it at a subsequent date, before they have really started it. This is dynamite, but it helps meet some of the world's most difficult deadlines. Of course technical projects can't be handled as easily this way.

Actually, announced goals should not concern the too-

distant future, anyhow. It is the pressing deadlines which must be fulfilled quickly that keep people hopping. If the project is a long one, it's a healthy device to chop it up into segments and schedule yourself accordingly.

It is, of course, unwise to set one's announced goal at an impractical height. With too great a gap between aspirations and achievement, you end up with your head in the stratosphere and produce little.

On the other hand, psychological research has shown that work moves faster through the use of an ascending aspiration level. Every time you've reached a part of the overall goal, notch up your time schedule for the rest.

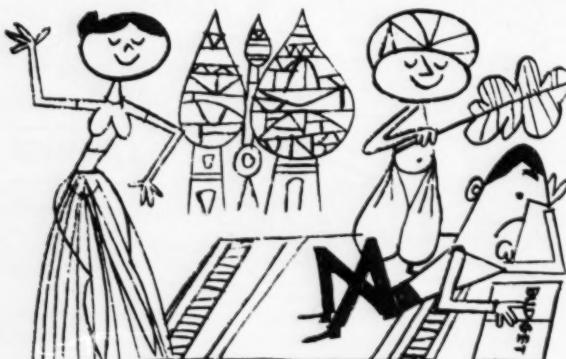
When you've chopped your goals down to size, and announced them, work out a set of rewards that you can offer yourself. They can be as simple as keeping yourself away from an enjoyed experience—anything from a ballet to a martini—until you have finished a scheduled number of pages of that paper you're working on. Or you can decide not to take that golf weekend until Project X is all wrapped up. Any doctor will tell you that this is good advice. No relaxation does you more good than that which can be enjoyed with the sense of task completed.

This system of rewards is especially useful for the man who switches from task to task. It combats the tendency to leave all tasks incomplete in the false glow of accomplishment on each one. The carrot technique is a strong incentive to wrap up some of the unfinished business and get on to other things.

Create an Environment Conducive to Productivity

Assume some added responsibilities. It's no accident that, on average, the married man tends to move faster than his bachelor stablemate. Property ownership, expensive hobbies, and the like are typical ways to make yourself want to do more—and earn more.

One top officer of a company comments: "I get my junior executives interested in golf, because I know they can't afford a country club. I want them to redouble their efforts so they can".

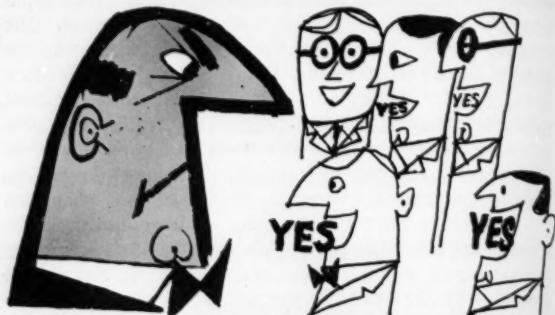


Assuming financial responsibilities can go too far.

The assumption of financial responsibilities can, of course, be carried to an absurd extreme that would be harmful to the peace of mind and working effectiveness of the individual. In most cases, all that is really needed is a mental linking-up of already existing loads with your work, to turn them into a positive incentive.

Another way to create a favorable environment for more personal production is to deliberately associate with people as able or abler than you are. The fellow who gets an idea that he's more competent and alert than most

of his friends falls into a slough of self-satisfaction that isn't going to stimulate him to any greater efforts. Constant association with active minds and active careers, however, gives ambition and pride that added jog that leads to higher personal productivity.



Don't surround yourself with yes-men.

A technical manager who surrounds himself with "yes men" is almost certain to be one who is failing to use his talents most effectively.

Another environmental trick is to consciously identify yourself with good reputations and traditions to live up to. The young engineering student who comes from a family of distinguished engineers probably has less special aptitude for engineering than he has a built-in drive to emulate his distinguished forebears.

Sometimes, the sheer desire to maintain one's own company's reputation in a particular field will turn the individual executive—with, perhaps, not a single share of stock—into a whirlwind.

Oftentimes, an individual can accomplish this same result even if he lacks readily identifiable grounds for ancestor worship—or even company pride. He can create for himself a particular kind of reputation which he then proceeds to live up to. For instance, a man with the reputation for punctuality makes it a matter of pride not to be late. The newspaperman with a pride in making deadlines doesn't often miss them.

Some psychologists will argue that all this supercharged performance and hopped-up motivation is heady wine for the average individual if he wants to live a long and healthy life. The answer is that this is not a prescription for an average individual, but rather one for a superior individual whose whole *raison d'être* is based on accomplishment—which is only another word for productivity. Further, these tricks are not recommended for those who have not already learned to plan and organize a specific project. Over-motivation and job-hopping, without real ability and organized habits, can be completely disastrous.

Supercharging available energy can at once be fun and challenging to the well-grounded and competent professional in any field. It is only those who do not belong in the managerial branch at all, that this method can throw into a case of the jitters.

Just as one river has more available water than another, so do individuals have varying ranges of energy. But the fact remains that very few of us are tapping our real potentials. Used judiciously, the techniques described above will almost certainly dig deeper into energy reserves and increase the usefulness and productivity of the man or woman who uses them.

END

A few reprints of four previous articles by Mr. Villalon are available at 25¢ each. Check the reprint ad on p. 44.



Introducing
THE NEW ADL
SOLAR FURNACE

3500°C of "pure" heat... **FOR HIGH-TEMPERATURE RESEARCH**

This is the new ADL solar furnace — a compact, flexible tool engineered for immediate application in high-temperature research.

With its highly polished, stellite-coated 60" paraboloid mirror, the furnace focuses the sun's rays into a spot of "pure" heat 6 millimeters across — a spot where temperatures reach 3500°C — half the surface temperature of the sun itself.

This is "pure" heat . . . since the test sample needs no crucible, there is no problem of contamination from a container, or from furnace walls. The high-temperature area can be sharply defined, and the desired temperature accurately controlled.

Heat can be turned on and off quickly, or maintained for hours at a time. Temperature and heat flux measurements are convenient and easy to make by means of instruments inserted through the viewing port at the back of the reflector. An experiment may be repeated within seconds by moving an unreacted part of the sample into focus. Adjustable-speed motors rotate the reflector on the horizontal and vertical axes.

The furnace can be modified to meet individual customer requirements. Arthur D. Little, Inc. invites your inquiries. Write:

Arthur D. Little, Inc.

30 Memorial Drive, Cambridge 42, Mass.

FOR MORE INFORMATION CIRCLE 6 ON PAGE 48

TO FACE FACE

R/E INTERVIEWS KINZEL OF CARBIDE ON

Duties of a V.P. of Research
Optimum Size of an R/D Lab
The Pros and Cons of Contract Research
Foreign Recruiting—Be Wary

QUESTION: How do your present duties as Vice-President differ from those of your old job, Director of Research?

ANSWER: The Director of Research is primarily concerned with the progress of work in the laboratories and the nature of the programs, whereas the Vice-President of Research has to do with overall research policies, total approach to the question of what, when, and how much.

Do the heads of research for the various divisions of Union Carbide report to you, the presidents of their companies, or to both?

The Vice-President for Research of a division reports directly to the division President. However, the research programs are reviewed in the Central Administration Department with respect to balance and context.

Does each division of Union Carbide set its own budget for research, or do you divide some total research stipend for the entire company?

Our divisional laboratories operate with two sources of funds. One of these is the division proper. It accounts for about 80 per cent of the total in each laboratory. This sum is set by the division and approved by the Research Committee and Central Administration. The other 20 per cent is allocated directly by the Central Research Administration and the Research Committee. In each case the important factor is the program, and the allocation of these sums is really

determined by the overall program. I understand that Union Carbide believes in a decentralized system of laboratories staffed by less than 150 technical personnel each. Is this still true? Is your big new lab at Parma, Ohio, a departure from this practice?

The first statement is broadly true, but requires explanation. We believe that the optimum size of a laboratory is about 125 (150 maximum) technical people, depending upon the type of work. This may mean a total of as little as 250 or as many as 600 or 700 employees. Parma is within these limits. We have just announced plans for a Central Research Laboratory to be devoted exclusively to basic research. This will supplement the divisional laboratories, but we do not plan that this laboratory will be larger than a divisional laboratory now or in the future. When one of our divisional laboratories reaches the maximum size cited above, a new laboratory is started in a new location. The recent establishment of a laboratory for the Linde Air Products Company at Speedway, Indianapolis, to include a portion of the work underway at Linde Tonawanda, is illustrative.

How do you evaluate a research project?

The decision as to whether to put a research project into production is based on an engineering analysis, an economic analysis, and a market analysis. Various techniques are used in each of these, but, in the last analy-



Dr. Augustus Braun Kinzel,
Vice-President of Research,
Union Carbide and Carbon Corp.

sis, none is better than the total of the facts which can be collected and in a truly new production venture such facts are apt to be either meager or debatable. There is little that is black and white. Individual judgment is the final answer.

How far along in the stages that lead to a marketable product do your research people follow a new product they originate?

Research is involved with growth and this includes the growth of people. Some researchers grow in research. They may find that after a number of years of research they prefer to get into production, or possibly sales. It is not uncommon for a researcher to transfer permanently to Development with a project that he has originated and for which he has been responsible. Similarly, it is not uncommon for one of our Development people to transfer to Production or Sales, if the product or process on which he has been working progresses to that stage. In any case, R/D people feel that while they would prefer to relinquish all responsibility when a product is transferred, experience shows that they must stand by to help when special problems arise. Our titanium project is an example. More than one researcher was transferred to Development by mutual consent when that project went from Research to Development and more than one Development man was transferred to Production when the plant was built.

(Continued on page 18)

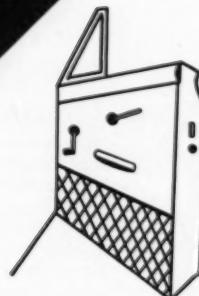
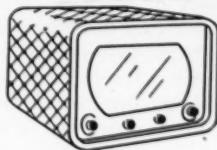


MIRRO-BRITE

DRESS UP
YOUR
PRODUCTS

STEP UP
YOUR
SALES

Metallized and Laminated
"MYLAR"**



Mirro-Brite "MYLAR" is a new development that offers unlimited possibilities in design effect and new sales potentials for manufacturers of all types of products. As you can see, it has unusual tensile strength as well as eye-attracting beauty . . . and it's most economical to use.

Extremely versatile, Mirro-Brite "MYLAR" can be processed in countless ways. It is available in a wide variety of color finishes, embossed patterns and special effects . . . in continuous rolls or cut-to-size sheets.

Send for illustrated sampler and price list.

COATING PRODUCTS

DEPT. RE6

101 WEST FOREST AVENUE

ENGLEWOOD, N.J.

*Mylar is DuPont's registered trade mark for its brand of polyester film.

ALSO SUPPLIERS OF MIRRO-BRITE, BUTYRATE, ACETATE, POLYSTYRENE & ETHYLCELLULOSE

FOR MORE INFORMATION CIRCLE 7 ON PAGE 48

Is your Jet Engine RPM Measurement Accurate???

The NEW B&H Instrument

TAKCAL

- COMPACT
- LIGHT
- RUGGED



• • • Reads Jet Engine Speed to Guaranteed Accuracy of 10 RPM in 10,000 RPM ($\pm 0.1\%$)

Checks
Tachometer
System
—
Adapts
to any
Frequency
Problem

The inter-relation of RPM to efficiency and thrust in jet engines is fundamental. Proper adjustments for maximum thrust, engine life and safety of operation can be made only upon accuracy of instrumentation.

The new B&H TAKCAL incorporates a refinement of the frequency meter principle. It operates in the low (0 to 1000 cps) range, reading the frequency of the tachometer generator on a scale calibrated in percent RPM corresponding to the engine's RPM. In addition, the TAKCAL checks the tach system. The TAKCAL circuit and tachometer are parallel so that readings can be made simultaneously to determine the accuracy (or inaccuracy) of the aircraft's tach system. The TAKCAL operates during the engine run to properly set up engine controls for maximum economy and safety.

The TAKCAL's component parts are identical with those used in the J-Model JETCAL Analyzer. They are here assembled as a separate unit tester and for use with all earlier models of the JETCAL Tester.

The TAKCAL operates accurately in all ambient temperatures from -40°F. to 140°F. Low in cost for an instrument of such extreme accuracy, it is adaptable to application in many other fields.

Explosion-proof TAKCAL for special applications. Measures 200 to 7500 RPM, direct reading, with $\pm 0.1\%$ accuracy.



For full information write or wire

B & H INSTRUMENT CO., INC.
3479 West Vickery Blvd., Fort Worth 7, Texas

West Coast Office: 427 E. Grand Ave.
El Segundo, Cal.

FOR MORE INFORMATION CIRCLE 8 ON PAGE 48

These transfers were on a permanent basis. Fortunately, in this instance, comparatively little additional help was required by the Production people. However, one problem did plague them—hydrogen content, where the initial specification had been seriously tightened. R/D undertook a serious study and solution.

Despite all the many research groups in Union Carbide, do you ever contract research problems to organizations like Stanford Research or the Mellon Foundation?

We have had contracts with Mellon ever since Union Carbide was formed in 1917. Our philosophy is to use contract research when both the people and equipment at such an institution are peculiarly adapted to the problem and when our own people either fail to meet this requirement or are preempted on some other problem.

Does Union Carbide have research contracts with laboratories in Europe? Have you been or are you thinking of setting up any European labs?

In answering the previous question, I should have added that one disadvantage of contract research lies in the fact that the experience and frequently the by-products, both of which are very important, do not accrue to the contractor in full measure. This applies to an even greater degree when we go overseas. Nevertheless, we do have a few such contracts in Europe with a few people who have shown extraordinary ability and creativity. In addition, we have a very substantial contract with European Research Associates, an internationally staffed basic research laboratory in Brussels. This is our approach to the problem of utilizing European brains and skills.

Are you recruiting any research people in Europe? How are they working out?

We have been, and are, recruiting research people in Europe. Obviously we select the cream of the crop and there is no question about their technical ability. However, many of these people find it difficult to adjust to the American way of life and a goodly number of them return to Europe too soon. The individual should have a

desire to come to the United States, even before he is approached.

What avenues of advancement are open to your R/D personnel?

In our research laboratories we have two progress ladders, one administrative and one scientific. The researcher is encouraged to progress up the scientific ladder and, as a matter of interest, there are cases in which our non-administrative scientists have higher remuneration than the local administrator.

Are you doing any work on batteries for very high-temperature operation such as in missiles or high-speed aircraft? How about atomic cells?

The National Carbon Company covers the entire field of batteries. Not only do we do research with respect to industrial goals, but also with respect to military goals. Some of this is done on our own initiative with Union Carbide money, and some of it under government contract. Our first study of ways and means of getting light from an atomic source dates back a good many years, and we believe it will be a good many years more before atomic energy can be used in a practical way in small devices.

How do you feel about the possibility of Russia gaining and maintaining a technological lead over the United States?

The Russians have always been known as good chess players. This shows that there is nothing wrong with their basic logic. They're also known to be creative. They have shown extreme good sense in elevating the position of the scientist in terms of prestige and income. This is bound to reflect in a quantitative increase of scientific accomplishment. It behooves us to mend our fences with respect to loss of talented people to non-scientific fields.

Thank you, Dr. Kinzel.

One of the nation's leading research metallurgists, Dr. Kinzel pioneered in the theory of stainless steels. Recently he spearheaded the research that led to the development of Union Carbide's new process for making titanium. He has served as a consultant to the various A. E. C. installations. A holder of doctorates in science and metallurgical engineering from the University of Nancy, France, Dr. Kinzel has lectured throughout Europe. Born in New York, he took his first degree at Columbia in math.

VACUUM

PRESCRIBED FOR YOUR PROJECT

THE FOUR AREAS WHEREIN KINNEY HIGH VACUUM OFFERS EXTRAS FOR YOU

- ✓ **QUALITY OF PRODUCT**
- ✓ **UNIFORMITY**
- ✓ **INCREASED PRODUCTION**
- ✓ **SOUND ECONOMY**

The vast experience of KINNEY engineers in Vacuum technology, as well as the vastly broader range in KINNEY High Vacuum Equipment, are self-evident advantages to you in the development of any project involving High Vacuum. KINNEY builds the most extensive line of Pumps in the world. There are sizes and models in KINNEY Pumps which enable you to virtually "custom tailor" your system with a Pump precisely suiting the need. For project or production — the sound answer in High Vacuum is — KINNEY.



HIGH VACUUM PUMPS

The range of sizes in KINNEY Oil Sealed Mechanical Pumps extends from small laboratory units developing pressures to 0.2 microns to large production two-stage Mechanical Booster Pumps providing ultimate pressures of 0.1 micron.

Additionally, there is a full range of sizes in high performance Diffusion Pumps in both Fractionating and Non-Fractionating Types.

HIGH VACUUM EQUIPMENT

Completely engineered standard units for Coating, Metallizing, Cathodic Etching, Sputtering, Crystal Growing, Vacuum Furnaces for Casting, Melting, Degassing and Refining, High Vacuum Distillation Equipment — Ultra-high Vacuums for Nuclear Reactors. Engineering and building special systems for individual requirements. Or, the development of complete High Vacuum Systems for high production and maximum automation.

KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY
3642B WASHINGTON STREET • BOSTON 30 • MASS.



GET THE FACTS

Write for full information on KINNEY High Vacuum Pumps and/or KINNEY High Vacuum Systems.

Kindly send me literature describing new developments in
 KINNEY High Vacuum Pumps KINNEY High Vacuum Systems
 Name _____
 Company _____
 Address _____
 City _____ Zone _____ State _____

FOR MORE INFORMATION CIRCLE 9 ON PAGE 48

au-to-má-tion

George H. and Paul S. Amber

"I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it. But when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind."—Lord Kelvin

Automation is like electricity: everyone uses it or talks about it but no one is quite clear about what it is. But that's not very important if, as Lord Kelvin pointed out, we can measure it.

This Automation Yardstick is an attempt to measure the degrees of automation.

The two basic units of automation are: energy, which does the work; and information, which controls the energy. We understand automation to be the sum of the individual automaticities of all stations or machines in a manufacturing process. The order of a machine's automaticity is raised by its ability to duplicate another of man's faculties.

Like the Fahrenheit scale's F, the Automation Yardstick's symbol is A: and the subscript gives the degree of automaticity.

The First Three Orders of Automaticity

A_0 is the zero order of automaticity. Hand tools are in this category. They are aids to man's working ability. They supply no energy—merely converting the energy put into them by their user's hand—and they certainly supply no information. They do not act in accordance

A U T O M A T I O N

ORDER OF AUTOMATICITY
HUMAN FACULTY ACCOMPLISHED BY MACHINE

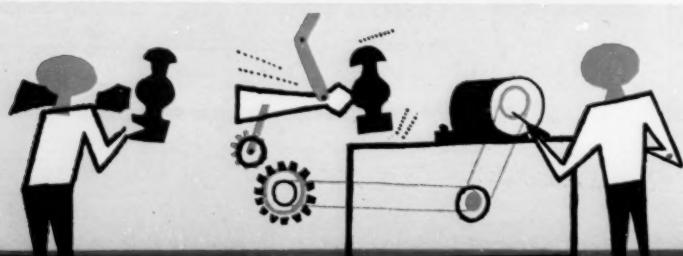
A_0 ZERO ORDER	A_1 FIRST ORDER	A_2 SECOND ORDER	A_3 THIRD ORDER	A_4 FOURTH ORDER
None. Replaces no human energy or control function.	Energy required to do basic machine function.	All energy required to do basic machine function. Also automatic feed.	Controls the machine.	Monitors machine performance.

CHARACTERISTICS
Includes all hand tools. They increase worker's efficiency, but replace no human function.

Includes all hand tools. They increase worker's efficiency, but replace no human function.	Uses mechanical power source, but machine feed and control completely dependent upon operator.	Uses 100% mechanical power, but operator must do complete set-up, and on-off and control.	Completely self acting—the first true automatics. Open-loop performance.	Measures machine performance, compares to a standard, corrects machine if necessary. Closed-loop feed-back control performance.
--	--	---	--	---

EXAMPLES
Shovel, knife, hammer, pliers.

Shovel, knife, hammer, pliers.	Cement Troweling machine; bench saws; pneumatic drill; portable electric tools; floor polisher; wood lathe.	Radial drill, bench lathe, power hack saw, pipe threading machine.	Turret lathe; transfer machine; grinding machines; gear hobs; screw machines; special manufacturing machines (cigarettes, lamp bulbs).	Ruling engine, heating machines, cold motion mill, chemical process plant, oil refineries, generators, speed regulators, tape decoders, product level controls.
--------------------------------	---	--	--	---



with built-in instructions, and so contain no significant information. Therefore hand-powered machines—knives, screw-drivers, egg-beaters—and foot-powered sewing machines are A₀.

A₁ machines are the power tools. These provide most of the energy required to do a job, but still require the guiding hand of a human operator to direct it, feed it material, and so on. So inasmuch as they supply one human faculty—the energy for a job, hand drills, power saws, jack hammers, punch presses, are A₁.

Adding power feed to power tools raises them to the next order of automaticity, A₂. Control is still the operator's job, but once the work is in place and the tooling set up, all he needs to do is start, stop, or change, the machine's controls. The machine is supplying all the energy needed to perform its work.

Once we have power drive and power feed, the next logical step is to have the machine control itself. Machines that control their operations have the third order of automaticity, A₃.

At last man can stand back and see a machine do an entire job, without his intervention. The *information* or how to do the job and the skill to do it, are built or set into the machine function, the tooling and the control

system. Examples of A₃ machines are automatic nail machines, automatic die-casting machines and automatic-cycle machine tools.

What Is Control?

Control in its simple form consists of turning-on or actuating a station; or as in the case of the turret lathe, transferring from one operation to the next on the same machine. Obviously, a control function built into an A₃ machine, such as a modern automatic-cycle machine tool, can also be used to actuate the control system on a succeeding machine. Whenever we have a series of A₃ machines with integrated sequential control systems, we have automation.

"Detroit" automation is largely of this type. Most of the individual machine tools are A₃. The machines are coupled together by conveyors, indexers, manipulators and positioners. These transportation machines between the machine tools proper, are also A₃ because they are completely automatic, providing all necessary energy; and by means of built-in routing and guides, the necessary pre-programmed information, too. Automatic, continuous-manufacturing special-purpose machines are on the A₃ level.

(Continued on next page)

Y A R D S T I C K

A ₅ FIFTH ORDER
Program calculations.

A ₆ SIXTH ORDER
Obeys complex logic, performs deductive reasoning.

A ₇ SEVENTH ORDER
Learns by experience.

A ₈ EIGHTH ORDER
Performs inductive reasoning. Has intuition and executive-type judgment.

A ₉ NINTH ORDER
Creativeness — originality.

A ₁₀ TENTH ORDER
Dominance.

Machine control is based on automatic solution of complex formal logic conditions (A ₅ and A ₆ overlap).
--

Telephone circuits, bowling pin spotter, elevator controls, cyclop machine controls, Robots.
--

Machine learns from its mistakes; attempts different modes of operation; improves its techniques.

Machine extrapolates from its experience, and forms modes of operation beyond actual experience, resembles intuitive operation and judgment.
--

Machine comes up with original, creative concepts, and can work beyond its programming.

Machines give the orders to the operators and designers.
--

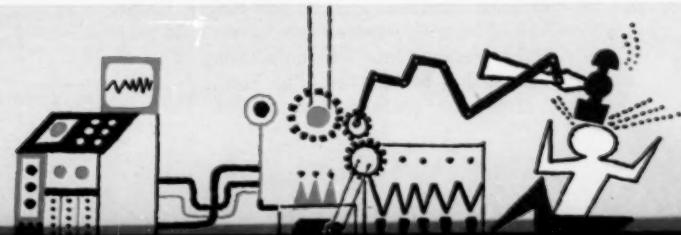
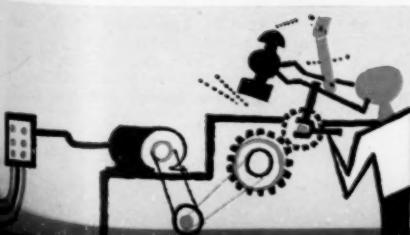
Automatic Operations Research machine that sets up much of its own local programming.

A paper talk machine, theoretically possible but has not yet been attempted.
--

Automatic Operations Research machine that sets up much of its own local programming.

Machine reproduces themselves.

Machines inherit the Earth.



The information built into a machine is a form of programming. An automatic screw machine obeys the program determined by the sequencing and set-up of the tools on the turrets. An automatic milling machine may follow the program represented by a master profile. No machine classed lower than A_3 can follow any built-in program, no matter how simple it is. Such A_3 programming is always accomplished by "hardware", straight mechanical, electromechanical, or electrohydraulic devices, such as followers and piece part duplicators.

Whenever the machining program is in the form of paper tapes, magnetic drums, punched cards, or other programs that are not physically set into the machines, automaticity greater than A_3 is usually required. This is because: one, some computations may be necessary to de-code non-hardware programs, as from paper tapes; and, two, the machines using taped programs are usually of the closed-loop, self-correcting feedback type.

For all practical purposes, today's automation is almost entirely A_3 . The machines are usually arranged so that the output of one machine feeds into the input of the next. In diagrams such automation resembles the tails-and-trunk line of circus elephants on parade.

Open- and Closed-Loops

We know that complex A_3 automation systems conform to the program designed into them faithfully. Too much so at times. The principal drawback of A_3 is this blind conformity characteristic. The machine goes right on operating, even if the tool is defective, or the parts fall outside of limits.

This characteristic of not automatically checking on machine performance is called open-loop by control designers. The A_3 machines are all open-loop, excellent for most routine heavy manufacture—not quite precise enough, or sufficiently flexible, for high-accuracy requirements.

Machines that check on their work can be said to have some judgment. These completely automatic closed-loop machines have the fourth order of automaticity, A_4 . They monitor their own output, automatically correcting their settings when necessary. Or, as in the case of some automatic honing machines, they continue with their function until the part is to proper size. A_4 machines of the self-correcting type, are most frequently encountered in continuous processes. To be properly classified, A_4 , the feedback (self-correcting signal) must refer to the basic work being performed to a standard. Any necessary linear corrections can be made by means of power servo actuators. An incidental non-basic self-regulating feature of a machine, such as adjustment of speed, temperature, or voltage, does not necessarily make it A_4 , since only the machine and not its product is directly affected.

Probability Effects

We know that the dimensions of parts produced on a machine usually exhibit a natural tolerance caused by the intrinsic non-assignable variation of the machine. Therefore, the dimensions of individual parts are usually of a random nature within the machine's dispersion zone, following the normal probability curve. The size of any individual part may fall anywhere from the high- to the low-tolerance limit and still be acceptable. Having a sensitive, closed-loop, self-correcting A_4 machine respond to individual measurements will only cause it to chase from one dimension to another. The result is that the machine's dispersion pattern is amplified. The closed-

George H. and Paul S. Amber are the design firm, Amber Brothers, Inc. They are the authors of Control Computers, a book dealing with the use of machine control computers for automation which will be published by Ronald Press later this year. They have published several articles on automation in the trade magazines and have delivered their Yardstick for Automation before the Society of Automotive Engineers.

loop self-correcting A_4 machine could produce more rejects than a conventional A_3 machine, without feedback, if the A_4 control system is not adequate.

One solution for having self-correcting features without the drawbacks of over-correction is to have the machine remember a part dimension, and not initiate corrective action until 2 or more parts indicate a definite trend or drift that must be corrected. This is known as post-process zone control.

Another solution is to compute the *machine mean*, the centerline of machine performance, for use as a self-correction index, instead of using an individual piece-parts measurement. This can be accomplished by means of small built-in special purpose analog computers. The computer calculates the machine-mean by averaging individual measurements. An advantage of a computed machine-mean is that the same computation is usable for an automatic quality control computer.

Fifth Order of Automation

A computer is a machine's program control system for the fifth order of automaticity, A_5 . These machines do not depend on a direct control or feedback signal. Instead, they respond to a mathematical function of either the control or feedback signal.

A_5 machines can compute the *machine-mean* to be used as a reference for self-correcting machines, or to be used for further automatic quality control computations. Such machines, with small built-in special purpose computers could do some of the routine design of the product they produce. Examples are punch presses that automatically position the stock so that the maximum number of piece-parts can be stamped out of the minimum amount of stock. Or, machines that design, and fabricate a wide range of shock absorbers, in accordance with dial settings of damping rate, travel, and frequency.

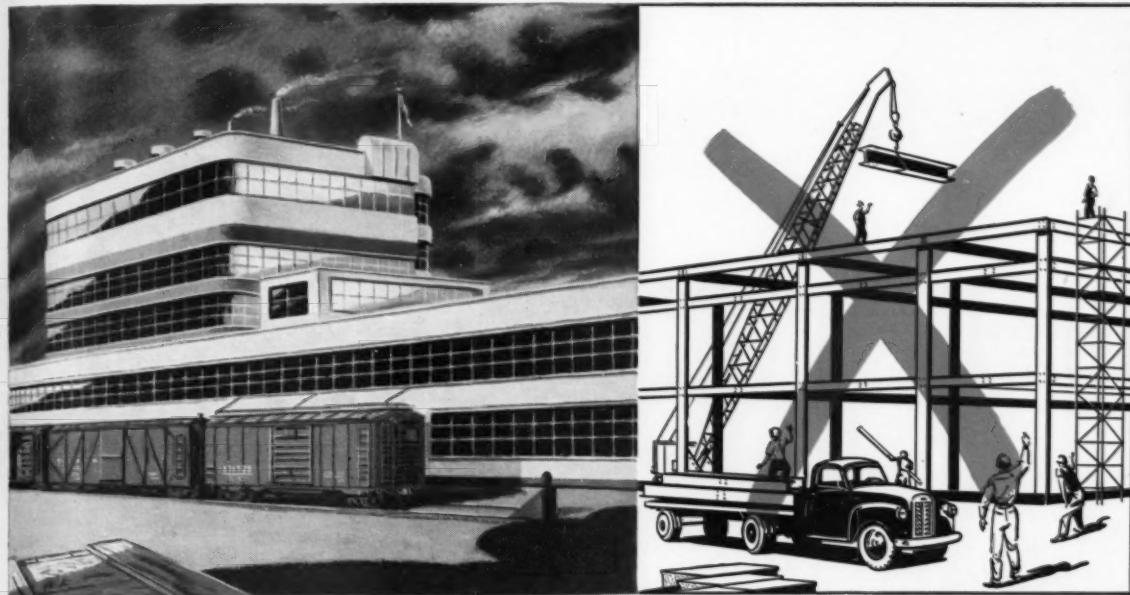
A machine tool with a built-in automatic machinability-computer would be another example. Such a machine tool would remove metal at the fastest permissible rate, taking into account the tool, surface speed, material, and other machinability variables, even if they are continuously changing.

The next big step in automatic machinery and automation involves A_5 machines. They may be years away, but only because of the normal inertia of industry, and the big investment in present machine tools. But the trend is toward A_5 . And what's more, the techniques and hardware for making up the many small analog computers necessary to A_5 machines, are already at hand.

From A_6 , automation machines move into the stuff of daydreams, through nightmares (A_7), and on into nightmares (A_8 , A_9 , A_{10}). END

Tearsheets of this and other articles appearing in R/E are available free to our readers. You can request one tearsheet of each article in this, the January, 1957, and all twelve 1958 issues from Editorial Offices, RESEARCH & ENGINEERING, 77 South St., Stamford, Conn. Complete copies are one dollar each in limited quantities.

memo to chemical management...



How to Expand Production without additional capital investment!

Consider these typical examples:

1. You plan to step up production of one of your present products. The manufacture involves intermediates. Your plant site is limited. *There may be no need to buy additional land or move your plant!* Here's what a number of Baker & Adamson customers have done. They have abandoned production of intermediates and purchased them instead from B&A. The space formerly devoted to intermediates is now used more profitably and efficiently for expanded production of their end product.

2. You plan to produce a new product. One or more "special" chemicals form part of the manufacturing process. In most cases, you will save time and money by buying these chemicals from B&A rather than making them yourself. Baker & Adamson is fully equipped to supply "custom-made" chemicals for such needs.

If either of these examples represents a situation you will soon have to resolve, we will be glad to explain in detail why you should call on Baker & Adamson. Here, briefly, are a few of many excellent reasons:

✓ As the country's leading producer

of extremely high purity laboratory reagents and fine chemicals, B&A can be depended on to meet your every requirement for fine and special chemicals in either L/C/L or tonnage quantities.

✓ B&A's versatile, adaptable facilities now produce several hundred products . . . are well equipped to supply "custom-made" chemicals for virtually every need.

✓ B&A's 27 sales offices and coast-to-coast chain of warehouses assure you of dependable, local service.

We invite your inquiries.



BAKER & ADAMSON®
Fine Chemicals
GENERAL CHEMICAL DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.



Offices: Albany* • Atlanta • Baltimore* • Birmingham* • Boston* • Bridgeport* • Buffalo* • Charlotte* • Chicago* • Cleveland* • Denver* • Detroit* • Houston* • Jacksonville • Kalamazoo • Los Angeles* • Milwaukee • Minneapolis • New York* • Philadelphia* • Pittsburgh* • Providence* • St. Louis* • San Francisco* • Seattle • Kennewick* and Yakima (Wash.) In Canada: The Nichols Chemical Company, Limited • Montreal* • Toronto* • Vancouver* • Complete stocks carried here.

FOR MORE INFORMATION CIRCLE 10 ON PAGE 48

LIMIT THEOREMS

Practical
Tool
for
Project
Evaluation



how R/E covered the management

of product access

in 19

here's ho
and pro
objec

JANU

1. Execu
2. Resea

FEBRU

1. Limi

4. Time

5. Human

MAR

6. The D

by

7. Econo

8. Man

9. Upgra

APRIL

10. Mon

11. How

12. The M

by

JUN

13. Rese

14. Desig

JULY

15. Plan

16. The

b

17. The

AUG

18. High

d

in

a

SEP

19. Gov

20. Water

OCT

21. Rese

22. Crea

NOV

23. Wal

24. The

DE

NOT

25. How

26. So

AN

The

GER

The collage includes the following titles and subjects:

- EXECUTIVE HEALTH
- TIME MANAGEMENT FOR THE RESEARCH EXECUTIVE
- How's Your Organizational Quotient?
- HUMAN ENGINEERING
- The Management Consultant
- The Formulation of Problems in Research
- THE CHALLENGE OF FRONTIER PRODUCTS RESEARCH
- TECHNICAL MANAGEMENT
- Planning on R&D Information Center
- THE CAUSE AND CURE OF EXECUTIVE INSOMNIA
- SO YOU'RE GOING TO MAKE A SPEECH
- WALL STREET LOOKS AT R&D
- GOVERNMENT R&D CONTRACTS
- Design Time and Money
- Punched Cards for Control
- LIMIT THEOREMS
- Practical Tool for Project Evaluation
- Creativity in R&D Research
- Economics Research in Development Programs
- Money and Manpower in Industrial R&D
- Research and Development for PROFIT
- HOW MUCH IS AN R/D BOSS WORTH?
- High Temperatures—Tool for the Future

Below the collage, the words "Research & Engineering" are printed in large, bold letters.

Dear Reader:

It takes time to **SAVE** time. We appreciate yours, in casting this ballot. We sincerely believe it will be returned many times over in the coming year, as we continue to save your time by providing a one source resource for management of product and process development in ALL fields of industry.

Wm. H. Relyea, Jr.

PUBLISHER

Product process development...in 1956

in 1956

Here's how R/E covered the MANAGEMENT side of product and process development—26 different articles on 26 different subjects! An average of more than two a month.

JANUARY

1. Executive Health: Fourteen Ways to Maintain It—by Luis J. A. Villalon
2. Research and Resources in the South—by Frank S. Soddy

FEBRUARY

1. Limit Theorems: Practical Tool for Project Evaluation—by Hilary Moss
2. Time Management for the Research Executive—by Luis J. A. Villalon
3. Human Engineering—by Robert B. Sleight

MARCH

1. The DP Problem: How to Handle the Difficult Person in Engineering—by Luis J. A. Villalon
2. Economics Research in Development Programs—by John Rivoire
3. Upgrading Technicians: More R/D Managers are Doing It—by Melvin Mandell

APRIL

1. Money and Manpower in Industrial R & D—by H. Wood
2. How's Your Organizational Quotient?—by Luis J. A. Villalon

MAY

1. How Do You Rate As An R/D Manager?—by David A. Emery
2. The Management Consultant: Help for the Busy R/D Manager—by Samuel D. Hobbs

JUNE

1. Research and Development for Profit—by Melvin Mandell
2. Design Time and Money—by Gerson Friedman and Isaiah Eisen

JULY

1. Planning A Research Information Center—by Herman Skolnick
2. The Challenge of Frontier Products Research—by William E. Hill and Warren B. Riley
3. The Formulation of Problems in Research—by Alfred M. Freudenthal

AUGUST

1. High Temperature: Tool for the Future. This was R/E's special issue, devoted almost entirely to all phases of high temperature in research, development and production, based on R/E editor's attendance at Symposium on high temperatures at Berkeley, Calif.

SEPTEMBER

1. Government R & D Contracts: Pitfalls and Procedures—by Max Hoberman
2. Water: A Review of Its Economic Importance in Industry—by Ronald C. Vickery

OCTOBER

1. Research Control—by Ronello B. Lewis
2. Creativity in R/D Teams—by Herbert A. Shepard

NOVEMBER

1. Wall Street Looks at R/D—by Ora C. Roehl
2. The Cause and Cure of Executive Insomnia—by Luis J. A. Villalon

DECEMBER

1. How Much Is An R/D Boss Worth?—An R/E Survey—by Scott Nicholson
2. So You're Going To Make A Speech—by Luis J. A. Villalon

AND—EVERY MONTH

* The Column "Technical Management"—edited by Dr. Merrit A. Williamson

again in 1957

R/E is going to present articles tailored to fit your needs, subjects that interest you. So that we may fit your measurements, **CAST YOUR BALLOT** by telling us:

1. Those articles in 1956 which
(a) you liked best
(b) helped you most

2. What subjects you are particularly interested in... what matters you would particularly like to have a report on.

BALLOT

Mr. Wm. H. Relyea, Jr., Publisher
Research & Engineering, 103 Park Avenue, N. Y. 17, N. Y.

Dear Mr. Relyea:

HERE'S MY VOTE ON 1956

No. of Article	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Liked exceptionally well														
Very interesting														
Extremely helpful														
Helpful background stuff														

HERE'S MY VOTE FOR 1957

General subjects of interest

Particular subjects
would like to hear about

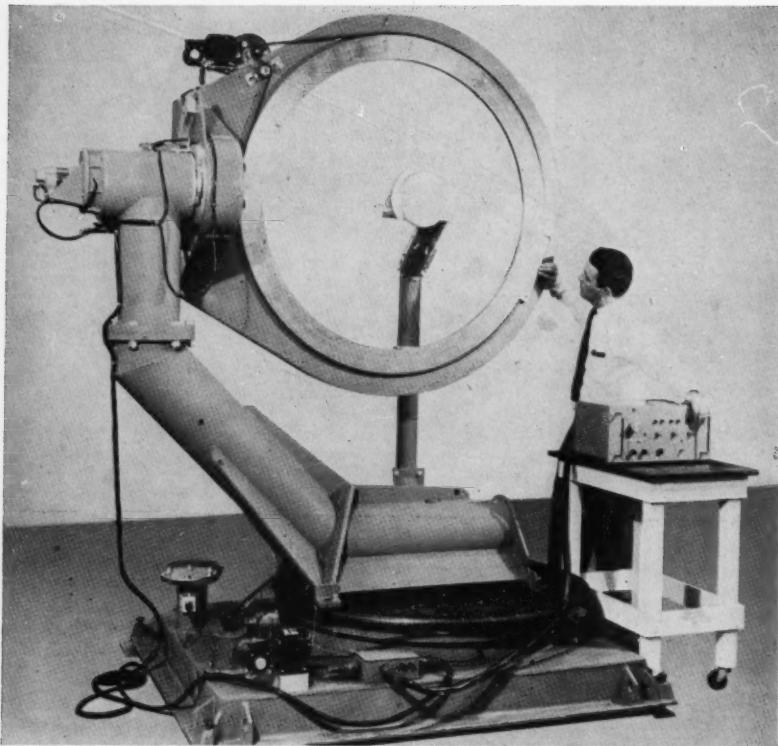
Additional
comments

My Name _____ Title _____

Company _____

YARDSTICKS

1 2 3 4 5 6 7 8 9 10



Radome Tester

A new radome boresight-error measuring system overcomes the serious problem presented by beam deflection caused by the non-uniformity of the plastic radome wall. Automatically recording beam deflection as a continuous function of radome position, the new process

requires far less time and does not miss discontinuities often overlooked by manual, point-by-point measurements. The photograph shows only the Radome Holding Fixture. California Technical Industries, 1506 Old County Rd., Belmont, Calif.

FOR MORE DATA CIRCLE 26 ON PAGE 48

Portable AC Millivoltmeter

AC measurements to 50 microvolts are accurately made with a new portable, battery operated, transistorized millivoltmeter. It is useful for in-the-field measurements for mobile equipment, general laboratory use, and as a broadband amplifier. Twelve full scale ranges between .001 and 300 volts a-c are provided as well as decibel coverage between -80 and +52 dbm. Usable frequency coverage is provided between 1 cycle and 5Mc. Fisher Research Laboratory, Inc., Palo Alto, Calif.

FOR MORE DATA CIRCLE 25 ON PAGE 48

Linear Potentiometer

A new potentiometer has been designed for high performance in severe environmental applications. It provides complete flexibility in mounting provisions, mechanical travel and electrical characteristics. Resistance is 30,000 ohms $\pm 10\%$; linearity $\pm 0.2\%$; and resolution, .001; power dissipation up to 2w. This new model withstands temperatures from -65°F to $+275^{\circ}\text{F}$; vibration 10g, 10 to 1500cps; and shock up to 60g. Humphrey Inc., 2805 Cañon St., San Diego 6, Calif.

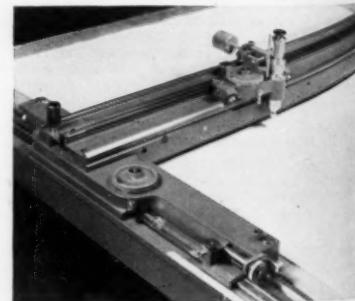
FOR MORE DATA CIRCLE 27 ON PAGE 48



Pirani Vacuum Gauge

A new one-to-four station Pirani vacuum gauge with a range from 1 to 2000 microns Hg is direct continuous readings of the total pressure of condensable vapors and permanent gases. It has two scales—1 to 50 microns Hg and 50 to 2000 microns Hg. The instrument has a new sensing tube which reduces zero drift, one of the greatest problems in previous hot-wire gauges. The tube operates at the very low maximum temperature of 250°C . Rochester Division, Consolidated Electrodynamics Corp., 1775 Mt. Read Blvd., Rochester 3, N.Y.

FOR MORE DATA CIRCLE 28 ON PAGE 48



Plotting Instrument

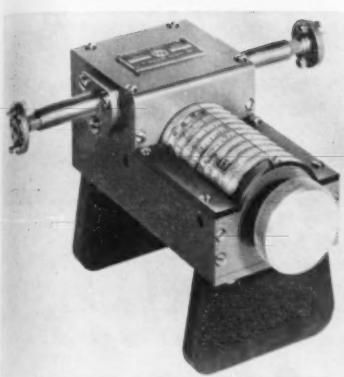
A new precision instrument plots points along X and Y coordinates within $.001"$ and is used for aircraft lofting, gage charts, and laying out small parts. It is also used to plot blades in a stack or flow patterns for turbine blades, to establish coordinate positions precisely for chart makers, and to plot reticles or targets for instrument manufacturers. The working area is a $47\frac{1}{2}'' \times 47\frac{1}{2}''$ table. Radii from $12''$ to $40''$ can be plotted. The pricker point unit has a 7 power microscope. Robert Sohngen, 210 East Courtland St., Philadelphia 20, Pa.

FOR MORE DATA CIRCLE 29 ON PAGE 48

Atte
Direct
wavegu
and acc
precision
pact u
frequen
in RG
brated
lateral
Electro
Pl., W
FOR MO

EHF
A new
tors ar
000Mc,
units w
ment a
The se
cw or
quency
microw
system
20 34t
FOR MO

Plug
A new
suited
applic
wire or
puters,
sequenc
essing,
trol. C
ready a
Baird-
Caird
FOR MO



Attenuation Reader

Direct attenuation readings over the full waveguide bandwidth with greater speed and accuracy is now possible with a new precision variable attenuator. This compact unit operates over the complete frequency range of 50 to 75 KMc/sec. in RG98/a waveguide. The unit is calibrated to 50db of attenuation, with bilateral matching. F-R Machine Works, Electronics & X-Ray Div., 26-12 Borough Pl., Woodside 77, N.Y.

FOR MORE DATA CIRCLE 30 ON PAGE 48

EHF Microwave Source

A new line of EHF microwave generators and sources, covering 18,000 to 50,000 Mc, utilize interchangeable tuning units which require no further adjustment after plug-in to the basic unit. The self contained instruments provide cw or modulated signals of known frequency for field or laboratory testing of microwave equipment, components and systems. Polarad Electronics Corp., 43-20 34th St., Long Island City 1, N.Y.

FOR MORE DATA CIRCLE 31 ON PAGE 48

Plug-in-Strip

A new model plug-in strip is equally suited for counting and data read-out applications. The decade counting, 10-wire output strip, can be used in computers, punch card systems and multiple sequence pre-set counters for data processing, recording and production control. Construction of this unit enables ready combination with other strips to meet a wide variety of requirements. Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass.

FOR MORE DATA CIRCLE 32 ON PAGE 48

Servo Indicator

A new, direct reading digital servo indicator supplies a highly readable digital counter type indication. Millivoltage or resistance changes are indicated swiftly, precisely, and the direct reading digital counter eliminates human errors from parallax and interpolation of reading that occur with dial and pointer scales. The Model 143 Indicator is excellent for measuring any linear variable where values change throughout a wide range. Some typical installations are now being used to measure the fuel flows and thrust of jet engines on static test stands. Gilmore Industries, Dept. 5011, 5713 Euclid Ave., Cleveland 3, Ohio.

FOR MORE DATA CIRCLE 33 ON PAGE 48

Low Frequency VTVM

This vacuum tube voltmeter has a frequency range of 2 cps to 250kc and a full scale voltage range of 3mV to 1kV. The instrument is equipped with a galvanometer-attenuation switch which makes it possible to obtain fast needle response on all measurements above 20cps while the necessary slow response is being maintained between 2cps and 20cps. Millivac Instrument Corp., P.O. Box 997, Schenectady, N.Y.

FOR MORE DATA CIRCLE 34 ON PAGE 48

Adds and Subtracts

A new electronic decimal counter that adds and subtracts may be used for servo control, net weighing, digital position control, ratio control, subtractive mixing, frequency deviation measurement, random events difference counting, digital to analog conversion, computer arithmetic elements and similar applications. To do subtraction the operator enters the minuend, complements, enters the subtrahend, and complements a second time. Victor Adding Machine Co., 3900 N. Rockwell St., Chicago 18, Ill.

FOR MORE DATA CIRCLE 35 ON PAGE 48

Transistor Tester

A new portable transistorized instrument is used for measurement of transistor parameters in circuit design and general trouble shooting. The unit has been designed specifically for measurement of Beta, h_{11} and I_{co} . Instrument is completely self-contained with its own 1kc oscillator and mercury cell power supply. Battery life of the mercury cell is about 1000 hours. The tester enables adjustment in direct reading calibrations to compensate for temperature variations. Baird-Atomic, Inc., 33 University Road, Cambridge 38, Mass.

FOR MORE DATA CIRCLE 36 ON PAGE 48

Low Power Decade Counters

Operating from a plate supply of only 150v dc at 7.5ma from 0 to in excess of 100 kc, a new series of low-power decade counting units is now available. Filling a distinctive need for low power decade operation, the 100L Series will provide models for pulse, analog or binary output and they have been designed to be physically and electrically interchangeable with most existing low power decade counters. Specifications include: Direct read-out in decimal numerals; Counting Rate: In excess of 100,000 pulses per second; Pulse Pair Resolution: about 5 micro-seconds. Computer-Measurements Corp., 5528 Vineyard Ave., N. Hollywood, Cal.

FOR MORE DATA CIRCLE 37 ON PAGE 48

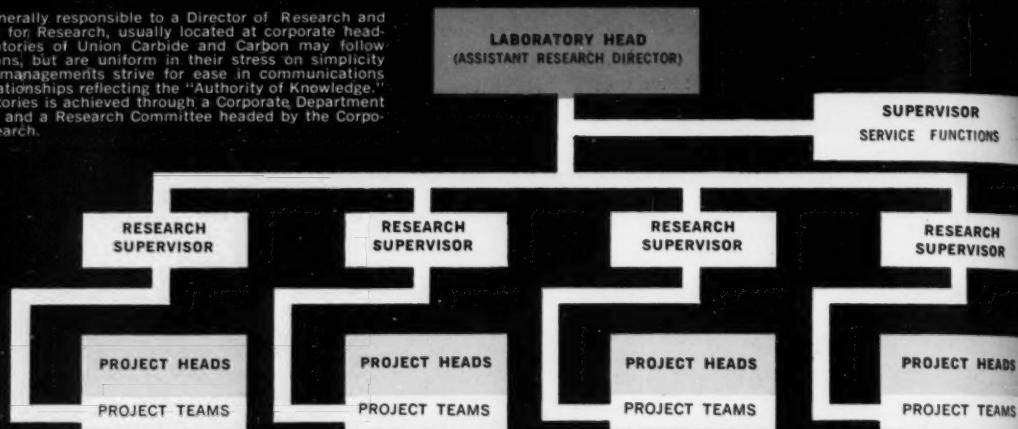
Digital Comparator

A digital comparator designed for use in digital servo control systems makes possible true digital control without recourse to counting techniques. In conjunction with a 13-bit or 19-bit shaft-position-to-digital converter, the comparator can provide digital control through conventional servo amplifiers and motors. This makes possible the application of digital control to existing servo systems with a minimum of change of components. A 19-bit comparator allows control to one part in 524,288. The device is particularly useful for airborne applications. Since no relays or tubes are used, this comparator can be readily packaged for demanding environments. Norden-Ketay Corp., Commerce Rd., Stamford, Conn.

FOR MORE DATA CIRCLE 38 ON PAGE 48

ORGANIZATION CHART: COVERING RESEARCH OPERATIONS OF A TYPICAL DIVISIONAL LABORATORY OF UNION CARBIDE AND CARBON CORPORATION

The Laboratory Head is generally responsible to a Director of Research and a Divisional Vice President for Research, usually located at corporate headquarters. Divisional Laboratories of Union Carbide and Carbon may follow different organizational plans, but are uniform in their stress on simplicity and flexibility. Laboratory managements strive for ease in communications and encourage informal relationships reflecting the "Authority of Knowledge." Coordination among laboratories is achieved through a Corporate Department of Research Administration and a Research Committee headed by the Corporate Vice President for Research.



organizing for effective R/D

ROBERT K. STOLZ

Is the organization of your laboratory essentially the same today as it was five years ago? If so, and if your staff is growing rapidly, there is a good chance that your organization plan is awkward and out of date, tending to hamstring your efforts. Here a leading management consultant gives his views.

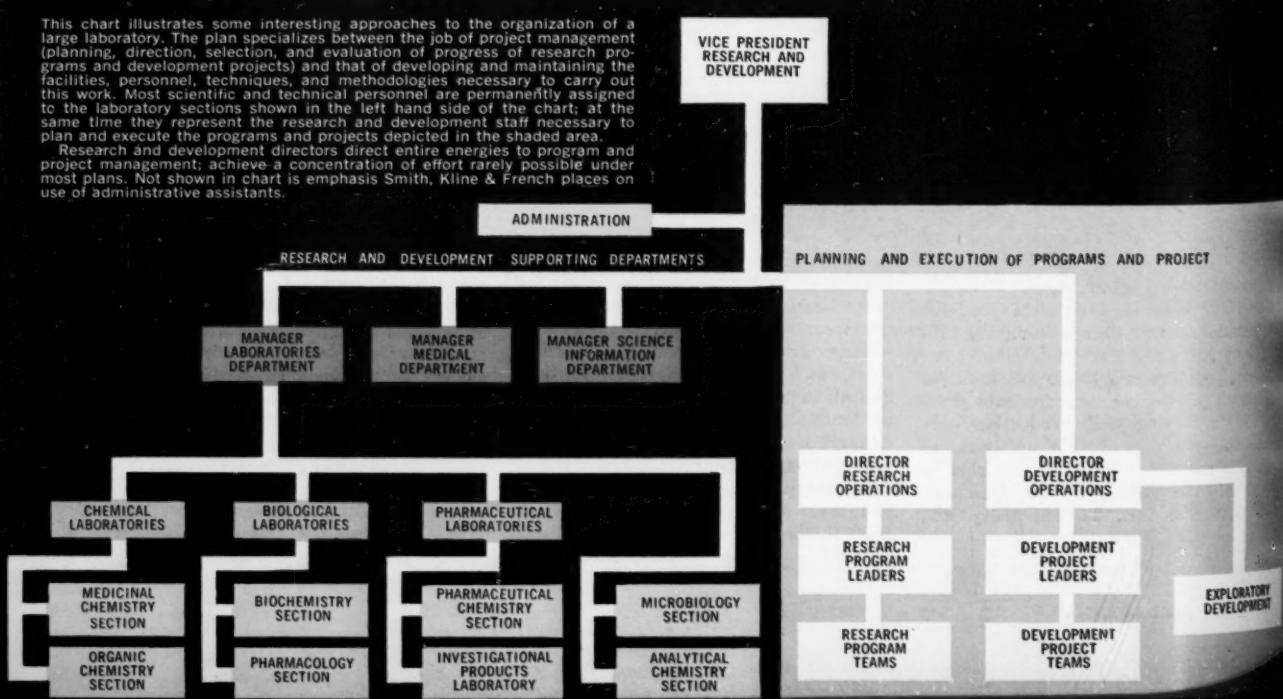
Judging from my experience, the typical research and development laboratory is beset by far more organization difficulties than are sales, manufacturing, accounting, or any other major function of business. Nowhere else is it as difficult to hold an individual accountable for results. One finds conflict between project teams and the permanent laboratory staff; too much administration and too little science; waste of scientific skills; and an unprofessional, unproductive atmosphere.

Why do these conditions prevail in R/D? One reason, of course, is that many labs have grown too fast for their own good. Most of them arrived at their basic organizational setup when they were small—when the R/D manager had direct personal contact with every scientist and every project. As the laboratories grew,

ORGANIZATION CHART: SMITH, KLINE, & FRENCH LABORATORIES RESEARCH AND DEVELOPMENT DIVISION

This chart illustrates some interesting approaches to the organization of a large laboratory. The plan specializes between the job of project management (planning, direction, selection, and evaluation of progress of research programs and development projects) and that of developing and maintaining the facilities, personnel, techniques, and methodologies necessary to carry out this work. Most scientific and technical personnel are permanently assigned to the laboratory sections shown in the left hand side of the chart; at the same time they represent the research and development staff necessary to plan and execute the programs and projects depicted in the shaded area.

Research and development directors direct entire energies to program and project management; achieve a concentration of effort rarely possible under most plans. Not shown in chart is emphasis Smith, Kline & French places on use of administrative assistants.



ORGANIZATION CHART: GENERAL ELECTRIC RESEARCH LABORATORY



At General Electric, research and development is decentralized in line with the decentralization of the company's business operations. In addition, the company has a corporate research service organization (shown here) charged with keeping abreast of the world of science in fields of important current and future interest. This organization does learning and teaching work rather than products research and development.

they went beyond the point where one man could realistically supervise all activities. Most companies failed to provide for this growth. As a result, responsibility for the R/D effort became widely dispersed throughout the laboratory.

The Mistake of Mimicking

Also, many technical managers have made the mistake of patterning their organizations after other departments in the company—sales, production, purchasing and the like. This imitation frequently misses. Research and development work is different. It is a professional, technical, problem-solving activity that has many unique organizational features. The standard, essentially military, line of command is not suited for the creative work of R/D.

Finally, many companies try to force an organizational marriage between research and development. The two efforts are somewhat incompatible and it is often difficult to mesh them smoothly. Over-all, research is easier to organize than development. A basic research problem usually involves the penetration in depth of a single highly specialized field. The development problem on the other hand, is broken down into

component parts, each handled in a different section of the lab with total progress requiring continuous coordination on all fronts. Lead time on development problems is much shorter. This means that the administrative load of planning, scheduling, selecting personnel, etc., is heavier, and the development organization must provide for this additional workload.

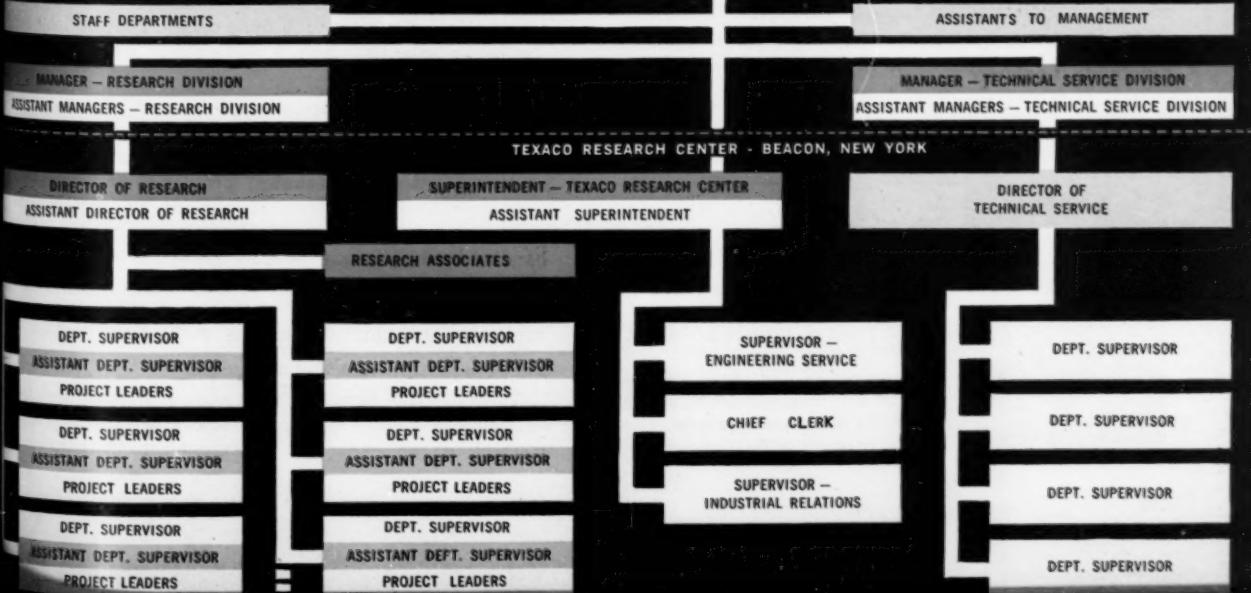
How can the organization plan handle this growing work load? There is no simple, clear answer. But from my experience in a number of R/D organizations, I believe that technical managers can accomplish a great deal if they will take the following seven steps:

Hold the Line on New Levels of Supervision

Three levels—a laboratory director, research supervisors, and project leaders—are enough for a laboratory of about 150 professional people. Most of the pressure to add new levels comes from the desire for more hands. From the supervisor's point of view, the obvious solution to his lengthening span of control is to break his department down into sections and appoint a section head over each one. This solves his immediate problem, but at the expense of adding a

ORGANIZATION CHART: THE TEXAS COMPANY

Technical service and research activities are serviced by operations Research Center Superintendent, who reports directly to top management. In the research area, the Project Team system is used. Flexibility is maintained since projects vary considerably in size and duration. Project teams may handle several related projects at the same time, and Project members are apt to work on several experiments concurrently.



new level of supervision. Organizationally, the better solution is to split the entire department in two—create two separate departments instead of one unwieldy one.

To have—as many laboratories have—five levels of supervision over the technical investigator is incompatible with a creative atmosphere. There is, for one thing, the ever present temptation for the supervisor to *supervise*. Though the management philosophy may call for him to participate in investigation only in a consultative capacity, in actual practice he constantly violates this concept, with the result that he curbs the professional man's independence.

Also, when several layers of supervision separate those who decide what investigations are to be conducted from those who are doing the work, instructions from the top tend to become garbled and misunderstood as they pass down the line. People who carry out the technical studies may actually work toward the wrong research objectives, or at best, proceed with the uncomfortable feeling of not being quite sure of what is expected of them.

A drawback too, is that ideas generated at the bench get lost or misinterpreted as they pass up the line from level to level. Any member of intermediate supervision can kill a good idea with a big loud "no," sometimes through misunderstanding, sometimes simply because no one can put an idea across as well as the person who originated it. Thus, in passing of ideas up through channels, the personal driving force is lost.

Responsibility becomes dispersed also. Too many supervisors leads to over-consultation, formality, and red tape. As one research manager said to me, "The more levels we added, the more difficult it became to get things done."

Set Up Independent Laboratories

How can the R/D manager cut back if a laboratory already has too many levels of supervision? One good way is to break the laboratory down into smaller, autonomous units. This may seem like going to great extremes to keep the organization simple, yet a number of companies are so convinced of the benefits of "smallness" for laboratory operations that they add new laboratories, rather than let established labs grow beyond a certain point. Union Carbide & Carbon has over the years adhered to a policy of limiting the size of its laboratories to about 125 professional people, adding new laboratories to meet the need for expanded effort in research and development.

Subdivide Logically

Not all R/D laboratories are alike. Each has special objectives, and the organizational breakdown must fit these special needs.



Robert K. Stoltz, a Yale graduate, is a Senior Consultant with McKinsey & Company, Inc. A specialist in management and organization, he has worked with R/D laboratories of many leading companies in planning and organizing R/D activity.

R/D subdivisions may be of several types; research versus development; or by major classes of research (i.e., new-product development versus product improvement); or by product line; or along divisional lines. It is important to choose the breakdown which best suits the R/D department's needs.

Clarify Responsibilities

In laboratories that superimpose project teams upon an established functional organization, coordination problems frequently arise. For example, one section of a laboratory may be held up because another lab unit is lagging behind, or one section may find that its work on a project has been rendered obsolete by developments in another unit of the same lab. "It's a minor miracle," one senior researcher in a well known development laboratory said to me, "when we manage to tie one of our projects together at the right time in the right place."

Why do wires get crossed this way? Usually because of an imperfect blending of the project overlay with the basic functional or department-section structure. The head of the project team, in theory, coordinates the various steps in the project with the department and section heads. In practice, the distinctions in responsibility between these two forms of organization are not clearly drawn. And as a result a fair amount of pulling and hauling is inevitable.

Therefore, there is a need to clarify both responsibilities of the project organization and those of the established department and section supervisors. These two can live together in harmony only if (a) they have quite different jobs to do, (b) the differences in their responsibilities are clearly defined and well understood by everyone concerned, and (c) each has the authority to carry out its assigned responsibilities.

Enlist the Help of Non-Specialists

I believe that trained researchers are doing far more clerical, administrative, and routine work than is necessary. Much of their laboratory work could be delegated to lab assistants.

Dr. Wayne Kuhn, General Manager of the Research and Technical Department of the Texas Company, points out that his company's laboratories have been working in this direction for some time. "We have found that we can go considerably further in turning over routine experiments to laboratory technicians than we once believed," says Dr. Kuhn. "Not only does it save considerable time of highly trained personnel, but we frequently get a better job done on the routine jobs, for our better scientists aren't particularly well adapted to repetitive work."

A great deal of supervisory time is also spent on administrative work. In a recent time study, we found that 18 percent of supervisory time in one R/D department was spent on technical problems, 56 percent on administrative, and about 26 percent on miscellaneous and waste. A good part of this work could have been handled by a lay administrative assistant. If only a third of the administrative load had been assigned to administrative assistants, the amount of supervisory time available for technical problems would have doubled.

Encourage Informal Relationships

The objective here is to let each individual feel free to approach anyone else in the laboratory for help, data, counsel, or an exchange of experience. A number of

benefits result from this freer communication.

First, each individual can find, through a process of trial and error, others whose counsel is stimulating and valuable. This builds up many productive relationships that could never exist in a laboratory that tended to work primarily through line channels. Second, this encouraging of informal relationships allows the natural leaders to emerge and stimulates their growth and development. Third, encouragement of informal relationships helps bring about an atmosphere that is both stimulating and productive of ideas.

De-Emphasize Rank

This can be achieved only if top laboratory management constantly demonstrates by word and deed that what a man knows and what he can do are more important than where he falls in the organizational hierarchy. It is a subtlety of organization that recognizes that no authority bestowed upon an individual by rank is a

guarantee that he will meet the requirements of his work. It recognizes also that in team effort there is the danger of conflict between the authority or organization and the authority of ideas. Thus, the de-emphasis of organization rank is necessary for an environment in which all individuals can get reasonably equal representation of their ideas. It also enables the individual who proves his ability to be assigned greater responsibility and achieve greater rewards without the necessity of making organizational changes.

R/D Organization . . . a Challenge

The professional, creative, problem-solving nature of research and development work requires new approaches and new thinking on organization. This is an area where departures from the orthodox will pay dividends. In the final analysis, not just one solution but many are possible. Finding the best plan requires careful study, imagination and sound judgment.

END



Now...
better
than
ever

CENCO—MEGAVAC *high vacuum pump*

For laboratory use . . . in the exhaustion of larger laboratory appliances either direct or in conjunction with diffusion pumps.

For industrial use . . . in the production of luminous tube lights, television tubes and similar products.

MORE EFFICIENT . . . delivers 57 liters of free air displacement at 600 rpm with $\frac{1}{2}$ h.p. motor.

MORE COMPACT . . . only $17\frac{1}{4}$ " x $10\frac{1}{4}$ " x $14\frac{1}{4}$ " overall.

Order Today or ask for Circular No. 1268

LONGER LIVED . . . Cenco precision engineering and manufacturing skill insures lasting, trouble-free performance.

Provided with convenient oil drain.

Cenco-Megavac No. 92003 mounted, with motor, 60 cycle, 115-230 volts
\$242.00

60 Cycle, explosion proof. **\$277.00**
Other motor types also available.



Central Scientific Company

1734 IRVING PARK ROAD, CHICAGO 13, ILLINOIS

BRANCHES AND OFFICES—CHICAGO • NEWARK • BOSTON • BIRMINGHAM • DETROIT •

SANTA CLARA • LOS ANGELES • REFINERY SUPPLY COMPANY—TULSA • HOUSTON

CENTRAL SCIENTIFIC CO. OF CANADA, LTD.—TORONTO • MONTREAL • VANCOUVER • OTTAWA

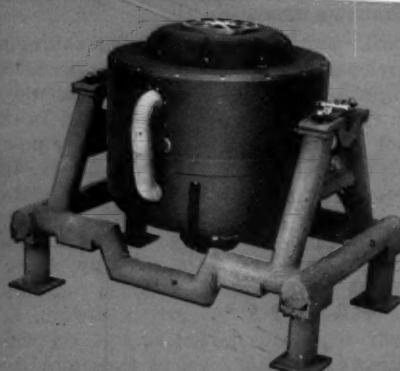
FOR MORE INFORMATION CIRCLE 39 ON PAGE 48

NEW

CALIDYNE

model 174 SHAKER

1500 lbs. force output



a basic shaker
for 6 different
CALIDYNE
Vibration
Test Systems

SYSTEM NUMBER	1 174/203	2 174/184	3 174/80	4 174/186	5 174/186	6 174/80
Type	Sinusoidal	Sinusoidal	Sinusoidal*	Sinusoidal*	Random or Sinusoidal	Random or Sinusoidal
Power Supply	Electronic	Rotary	Electronic	Electronic	Electronic	Electronic
Force Output	1250 lbs.	1500 lbs.	1500 lbs.	1500 lbs.	1500 lbs.	1500 lbs.
Frequency Range	5-3500 cps.	5-2000 cps.	5-3500 cps.	5-3500 cps.	5-3500 cps.	5-3500 cps.
Max. Load 10 g.	105 lbs.	130 lbs.	130 lbs.	130 lbs.	130 lbs.	130 lbs.
Max. Load 20 g.	42.5 lbs.	55 lbs.	55 lbs.	55 lbs.	55 lbs.	55 lbs.

*Also adaptable for Random Vibration Testing.

CALIDYNE'S Model 174 Shaker featuring high frequency operation and low input requirements has been so designed that it can be utilized in any one of six CALIDYNE Vibration Test Systems.

The versatility of the Model 174 Shaker extends the range of vibration testing for which this shaker can be used. It further advances CALIDYNE Systems of vibration control, enabling equipment manufacturers to: create vibratory forces over a wide range, measure them, use them for testing and measuring the test results.

Typical vibration testing applications of these Model 174 CALIDYNE Shakers include:

1. Brute force shaking at frequencies simulating the worst conditions of ultimate operation.
2. Structural response to determine mode shape, frequency and damping characteristics.
3. Fatigue testing for high stress providing deflections many times greater than normal usage.
4. Random vibration testing for more exact simulation of true environment.

Complete performance data on each of these 6 CALIDYNE Series 174 Shaker Systems are contained in New Bulletin 17400. For engineering counsel in applying the destructive force of vibration to your own research and testing problems, call us here at CALIDYNE.



THE **CALIDYNE** COMPANY

120 CROSS STREET, WINCHESTER, MASSACHUSETTS

SALES REPRESENTATIVES

NEW ENGLAND, NORTHERN NEW YORK Technical Instruments, Inc. Waltham, Mass. (Twinbrook 3-1400) Syracuse, N. Y. (Syracuse 3-7870)	VIRGINIA, MARYLAND, WASHINGTON, D. C. F. R. Judson, Inc. Washington, D. C. (Oliver 2-4404)	ARKANSAS, LOUISIANA, OKLAHOMA, TEXAS (Except El Paso) John A. Green Co. Dallas, Texas (Riverside 3268) Houston, Texas (Jackson 3-0212) Tulsa, Oklahoma (Riverside 2-4577)
NEW YORK CITY, LONG ISLAND, NEW JERSEY, NEW HAMPSHIRE, EASTERN PENNSYLVANIA C. Curtis Engel & Associates Ridgewood, N. J. (Gibraltar 4-0773) Syracuse, N. Y. (Syracuse 1-5092) Philadelphia, Pa. (Chestnut Hill 8-0892)	SOUTH CAROLINA, GEORGIA, ALABAMA, FLORIDA, SOUTHERN TENNESSEE Specialized Equipment Corp. Cocoa Beach, Fla. (Cocoa Beach 3328)	CALIFORNIA, ARIZONA, COLORADO, NEW MEXICO, NEVADA, OREGON, WASHINGTON, UTAH, WESTERN MONTANA Gerald R. Miller Hollywood, Calif. (Hollywood 2-1193) San Diego, Calif. (Academy 2-1212) Bakersfield, Calif. (Bakersfield 2-1111) Tucson, Arizona (Tucson 4-4253) Denver, Colorado (Acoma 2-9276) Albuquerque, New Mexico (Albuquerque 3-8606)
OHIO, WESTERN PENNSYLVANIA, EASTERN MICHIGAN P. A. T. Associates Westlake, Ohio (Trinity 1-8000) Dayton, Ohio (Oregon 4441) Pittsburgh, Penn. (Freemont 1-1231) Detroit, Michigan (Broadway 3-5399)	INDIANA, ILLINOIS, WISCONSIN, WESTERN MICHIGAN, N. DAKOTA, S. DAKOTA, NEBRASKA, IOWA Hugh MacLeod and Co. Chicago, Ill. (Ambassador 2-1555) Minneapolis, Minn. (Glendale 3803) Minneapolis, Minn. (Coffey 7949)	

FOR MORE INFORMATION CIRCLE 40 ON PAGE 48

r/d contracts

Atomic Center for Greece

A new Greek National Atomic Energy laboratory will be named for Democritus, first proponent of the atom. Contract to design and build the nuclear research reactor, near Athens, has been awarded to AMF Atomics, Inc., subsidiary of American Machine & Foundry Co. Construction is scheduled to begin in October, and the reactor to be placed in operation in the Spring of 1958.

Research Contracts

Twenty unclassified physical research contracts have been awarded by the U.S. Atomic Energy Commission, to universities and private research institutions. Three of these are new, the remainder renewals of contracts which have been in force.

New contracts are in force with: University of Arkansas for the study of Structure of Liquids by X-Ray Diffusion. Investigators are P. C. Sharrah and R. F. Kruh. Amount of grant, \$16,445.

Reactions Between Solid and Liquid Metals and Alloys are being studied at Harvard by Bruce Chalmers on a \$29,770 budget.

Non-Aqueous Solvents reactions are being investigated by Helmut M. Haenler at University of New Hampshire on a grant of \$7,935.

The following are renewals:

Preparation, Structures and Properties of Heteropoly Ions, by L. C. W. Baker, at Boston University, for \$18,171.

Application of Isotopes in Chemical Kinetics, at University of Buffalo, by G. M. Harris. Grant is \$21,000.

Synthesis of Beta-Diketones and Beta-Ketoesters with Heterocyclic Nuclei, at University of Pittsburgh, by R. Levine, under grant of \$9,915.

Structure of Metallic Liquids, Scope I—Ultrasonic Measurements of Liquid Metals and Alloys. Scope II—Galvanomagnetic Properties of Liquid Alloys. Columbia; Researcher, Robert B. Gordon; grant, \$7,120.



Photo courtesy of North American Aviation, Inc.

Chopper simplifies missile telemetering

How to get maximum performance in a tiny telemetering amplifier for guided missiles—that's the problem that faced engineers at North American Aviation's Missile Development Division.

Their answer was a plug-in, etched-circuit, transistorized amplifier (above), using the Bristol Syncroverter[®] chopper to convert d-c signals to a-c for radio transmission.

Outstanding long life and immunity to shock and vibration are the big reasons engineers so often pick the Syncroverter chopper—or similar high-speed polar relay—for missile guidance and telemetering. And for air navigation equipment, computers, and carrier current switching, too.

The Syncroverter's output waveform is negligibly affected by vibration up to 30G over the frequency range of 5 to 2000 cps.

If you need a light-weight, rugged, reliable chopper; you'll find a wide variety of Syncroverter performance characteristics available. Those below are typical. Write for complete data. The Bristol Company, 169 Bristol Road, Waterbury 20, Conn.

6.67

®T.M. Reg. U.S. Pat. Off.

TYPICAL OPERATION

Driving frequency range:	0-2000 cps (400 cps used for these characteristics).
Coil voltage:	6.3 V sine, square, pulse wave.
Coil current:	55 milliamperes
Coil resistance:	85 ohms
Phase lag:	55° ± 10°
Dissymmetry:	less than 4%
Switching time:	15° ± 5°
Temperature:	-55°C to 100°C
Operating position:	Any
Mounting:	Flange or plug-in—fits 7-pin miniature socket.

These characteristics based on sine-wave excitation.

BRISTOL

Automatic Controls • Recorders • Telemeters
Screw Sockets • Choppers and High-Speed Relays
Aircraft Pressure-Operated Devices

FOR MORE DATA CIRCLE 81 ON PAGE 48

Thermodynamics of Metallic Solutions; Solid Solutions and Grain Boundaries; Fundamentals of Cold Working and Recrystallization. Investigators, M. B. Beaver, M. Cohen and B. L. Averbach, at MIT. Grant is \$112,300.

Tracer Element Distribution Between a Solid and a Melt at U. Conn., by Roland Ward and W. C. Orr, \$5,000.

Isotope Exchange Reactions study by Clifford S. Garner continues at UCLA on a grant of \$33,209.

Electrochemical Studies of Non-Aqueous Melts. G. Derge at Carnegie Tech., \$33,000.

Measurement of Thermal Conductivity of Refractories, by F. H. Norton at MIT, under a grant of \$35,100.

Nuclear Reactions with Fast Alpha Particles, Neutrons, and Deuteron and a Study of Nuclear Structure. E. Bleuler, at Purdue Research Foundation, \$62,170.

Polar Inorganic Molecules. At Rutgers by E. R. Allen under grant of \$15,323.

Fundamental Study of Radiation Damage of Metals and Alloys by Means of Special X-Ray Diffraction Methods. S. Weissmann and J. J. Slade, Jr.; Rutgers, \$16,465.

Radiochemistry research at Columbia University by J. M. Miller; \$29,185 grant.

Physical Properties of Liquid Metals and Alloys. W. D. Robertson, Yale, \$12,250.

Application of Adiabatic Calorimetry to Metal Systems. University of Tennessee, E. E. Stansbury. \$7,800.

Interactions of Medium Energy Neutrons and Polarized Photons in Matter. Frank L. Herford at University of Virginia. Grant is \$20,900.

The Permeability Method of Determining Surface Areas of Finely Divided Materials. Luther Lyon, University of Wichita. No Fund.

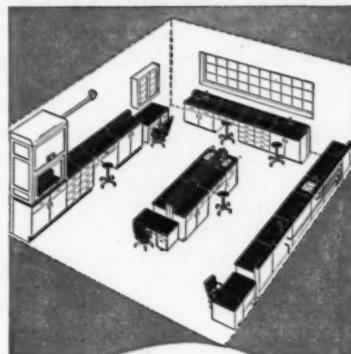
Lead in Ceramics

Lead compounds in ceramics and ceramic coatings permit lower firing temperatures. The Lead Industries Association in New York has granted \$2500 to the School of Ceramics, Rutgers University, to research the role of such compounds in ceramics.

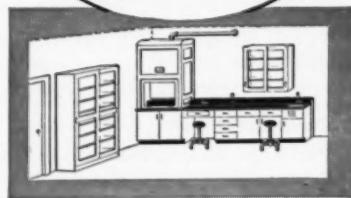
FISHER

Unitized

FURNITURE



**Fits ANY
SIZE, SHAPE
OR TYPE OF
LABORATORY**



Unitized furniture is made in a wide variety of standard stock units and accessories. They provide an almost limitless number of assemblies with which to meet the exact requirements of any size, type or shape laboratory. Once installed, they can be just as easily dismantled and re-assembled—together with additional units, if desired—to meet the ever-changing needs of a progressive laboratory.

WRITE FOR FREE FURNITURE CATALOG

It shows suggested layouts, ease of installation and complete description of all furniture units and accessories.

115 Fisher Building,
Pittsburgh 19, Pa.



**FISHER
SCIENTIFIC**

Boston Buffalo Chicago Charleston, W. Va.
Cleveland Detroit New York Philadelphia
Pittsburgh St. Louis Washington Montreal-Toronto

America's Largest Manufacturer-Distributor of Laboratory Appliances and Reagent Chemicals

FOR MORE DATA CIRCLE 82 ON PAGE 48



The next criterion has to do with the technicians efforts to improve himself through education. Is there a place on everyone's personnel jacket for a record of what he's done in this regard? Programs of further education are widely used today and they present an unparalleled opportunity for the engineer or scientist who wishes to get ahead. Programs can be arranged with nearby universities, which will often offer courses in their extension programs. Correspondence courses, such as the Alexander Hamilton Course in Modern Business, LaSalle, or International Correspondence School also are available. Some of these programs lead to degrees. Others impart essential information directed specifically to the business of the organization.

Often courses are given by men on the staff. This has very beneficial results. The person teaching profits. And he is able to observe the interest and ability level in different people. It lets him compare the brainpower from division to division. It also discovers who is interested enough in his work to take a course.

In my opinion, the courses which scientists and engineers need most are courses slanted toward management: accounting, getting along with people, handling grievances, public speaking, elements of patent law, report writing, communications, etc. These are all a part of making a better professional man. Recognition and encouragement of these activities help to keep the staff alert and alive. In engineering, when a man feels he has arrived, then his utility is impaired. It may not cease, but it certainly will not increase.

Outside Activities

Participation in affairs of the community, local service clubs, company organizations, the Credit Union, committee memberships, both within the company and outside, are important in providing experience which makes the worker more valuable as a professional man.

Membership in professional societies is also important. It is hard to conceive of a man as a professional who does not participate in the affairs of the local branch of at least one technical society. The company might encourage such participation by the payment of at least one membership, provided of course that actual participation follows. Another area of service lies in part-time teaching, either in the plant or at a nearby school. Publication of papers should be encouraged and all help possible provided for each person to attain a reputation outside of the company. There are tremendous rewards that accrue to the individual through such recognition in the scientific press, and the company also profits from this tremendously.

A Professional Development Program

Although it is difficult in the larger organizations, I personally feel that it is well worth while for someone to be concerned with the preparation of a professional development program for each person. This, of course, requires that a contact be made with the person to see in what direction he wishes to move and then help him to lay out a program of advancement. The value of this personal interest in the employee's mind is tremendous. It enables him to obtain the satisfaction of moving to-

TECHNICAL MANAGEMENT

ward a goal. In my opinion he should attribute his own achievements to his company's cooperation and not feel that he has accomplished something in spite of the company or that he fought against odds. This attitude will make men lose interest in their jobs and will make it difficult for your recruiters.

We have talked about engineers. How one promotes technicians to scientists, I do not know. To the best of my knowledge there is no comparable examination. I would like to hear from readers on this point.

More on Goff and Fall

Do you remember the case of the Unenthusiastic Manager? The one involving Mr. Goff and Mr. Fall. This first appeared in the September issue and then was further clarified in the December issue. Here is the problem, to refresh your memory:

"Mr. Goff is Director of Research. Mr. Fall reports to him. Mr. Fall has three sections in his department with a total of about 20 people. There has been an organizational change which does not affect the reporting of any of the persons but does mean that there will be a cut back in technical work. Responsibility for the remaining work will be given to another department. Mr. Goff believes this other department is more competent to handle it but Mr. Fall feels that his own department is better qualified. Fall presents his reasons for feeling as he does. He advances the argument that the personnel in his department will resent being bypassed. Mr. Goff, after unsuccessfully trying to convince Fall this isn't so, tells him that the change will go into effect despite his opposition.

How does Fall proceed? How does he announce the change to his staff? Does he pass the directive along without comment? What does he say if asked how he feels about it? Does he pass it along as though he were enthusiastic about the idea and give all the reasons which Goff has given him in support of the change? How should instructions be relayed to the department in these circumstances? Can you give guiding principles?"

W. H. Newberry, Assistant to the Technical Director, Olin-Mathieson Chemical Corporation, after following a line of reasoning which Mr. Fall might take, has Mr. Fall ask himself, "Will I have been expected to have some influence on my group's attitudes?" Suppose Mr. Fall follows our line of thought thus far and decides that it is up to him to exert some positive influence on the side of giving the change a fair trial. How should he go about it? With R/D personnel, with their training in protecting a trial of any kind from the influence of uncontrolled variables, what more effective means could be found than to lay the cards on the table and tell his section heads: 'I've told Mr. Goff we don't think this change will prove to be a good one. A few months from now I may have to be telling him that we've tried to live with it, and it just isn't working out. If that happens, the first thought in his mind will naturally be: 'Have we given it a fair trial?' So I'll need to be in a position to tell him that we have. I won't be able to do that unless we can line up our people to give it a fair trial. How about it? Can we do it?"

John V. E. Hansen of Brighton, Massachusetts, presents an interesting discussion ending with two guiding principles worthy of consideration:

"I note that, according to the presentation of the case, Mr. Fall has used, as one of his arguments against the proposed move, the fact that departmental personnel find it undesirable. This obviously implies that Mr. Fall took the liberty of discussing the proposed move in considerable detail with the departmental personnel prior to the time the final decision was made. This in my judgment, is a basic error. I would think that Mr. Fall would have been able to sense the nature of the reception that the proposed change would encounter if he enjoyed good rapport with his own personnel. More important however, is the general undesirability of giving out too many details of a proposed move prior to a final decision.

"Assuming that this situation does exist, however, and assuming that Mr. Fall would now accept advice as to the best manner of proceeding, I would recommend that he review the case in his mind to determine why Mr. Goff wants the proposed move. While the move may have some undesirable effects as far as the people directly under Mr. Fall's supervision are concerned, it would be reasonable to assume that the move would have a desirable effect on the over-all organization, presumably as explained by Mr. Goff to Mr. Fall. This would constitute a basis for Mr. Fall to sell his people on it.

"As to the manner of presenting the decision, if Mr. Fall were to pass along the directive with comments that it was not his idea, there would be a strong implication of outright contradiction and therefore a lack of loyalty to his own superiors. This, of course, is definitely unde-

sirable. Inasmuch as Mr. Fall had already taken the liberty of discussing the matter with his personnel, a complete reversal to an enthusiastic report of the proposed move would also seem unrealistic. Therefore, a straightforward statement to the effect that the proposed move is to be put into effect together with certain general reasons for the move would be in order. I would suggest that Mr. Fall discuss the detailed reasons for the move with his personnel supervisors and explain that, from an overall organizational standpoint, all personnel involved would ultimately benefit. It would then be the responsibility of the leading personnel to use their discretion as to the amount of information they pass along to the other personnel in explaining the situation.

As far as guiding principles are concerned, I would think that they come down to the fairly basic ones that always seem a simple application of common sense.

1) Preliminary discussions regarding proposed moves should be restricted to those personnel, and only those, who absolutely need to know. If necessary, other personnel should be sounded out in a very general manner, but this is a practice to be avoided.

2) Faith in one's own ideas is always commendable, but not at the risk of upsetting an organization. A strong support of one's own ideas is warranted until a final decision is made; beyond that, it becomes necessary to see the virtues in a superior's orders and employ these to achieve the desired end in the most harmonious manner. Where the instructions to personnel are apt to represent a drastic change or are apt to create concern, a supplementary conference on an informal basis with leading personnel is recommended.

END

PROBLEM #3

Design a miniaturized 400 cycle power transformer for airborne operation, with a three phase primary and three secondaries: three phase, two phase and single phase. Transformer to operate in an ambient temperature ranging from -55°C to $+85^{\circ}\text{C}$. The maximum allowable temperature rise to be 40°C over ambient. Transformer to operate at altitudes up to 50,000 feet. Dimensions cannot exceed 5" high, by 2 $\frac{1}{4}$ " wide, by 2 $\frac{1}{4}$ " long, with (c) loaded intermittently. All secondary windings to be ended in four terminals. Construction to be in accordance with applicable parts of MIL-T-27, Grade 1, Class A. The above are given as maximum dimensions and minimum performance requirements, greatest possible improvement in size, weight and performance requested.

SOLUTION BY PEERLESS

Power Transformer, three phase, 400 cps to one phase, two phase, and three phase

Construction: Grade 1, Class A, to MIL-T-27

Ambient Temperature Range: -55°C to $+85^{\circ}\text{C}$

Temperature Rise: 35°C

Primary: Three terminal, three phase, 115V, 380-420 cps, per phase

Secondaries: Total of four terminals

- (a) 30V, three phase at 1.8A and .5 lagging power factor. Continuous duty.
- (b) 30V, single phase at .4A and .7 lagging power factor. Continuous duty.
- (c) 115V, single phase, at .47A, .7 lagging power factor and in quadrature with (b) within $\pm 1^{\circ}$

Weight: Two pounds

Dimensions: H: 4-1/32" + $\frac{1}{2}$ " seven terminal header; W: 2-1/32"; L: 2-9/32"

Experience in designing transformers to meet and exceed the most unusual and difficult specifications gives the Peerless engineering staff unique qualifications that speed the solution of every transformer problem. This background combines with rigid quality controls and advanced production techniques throughout the Peerless plant to achieve uniform quality and dependability in all Peerless products.

Consult Peerless for the best solution to your quality transformer requirements.

PEERLESS
Electrical Products



A DIVISION OF **ALTEC**
COMMUNICATIONS EQUIPMENT

1515 S. Manchester Ave., Anaheim, Calif. • 161 Sixth Avenue, New York 13, N.Y.

FOR MORE INFORMATION CIRCLE 42 ON PAGE 48



SCIENTISTS



Stimulation, status, security . . . the absorbing challenge of the rocket propulsion field, the rewards of professional recognition, the stability of a firmly established organization . . . are yours at Aerojet-General.



Aerojet offers experienced chemists, physicists, mathematicians and metallurgists, and recent graduates unparalleled career opportunities on a variety of important problems.

- Conduct studies of new liquid or solid propellants.
- Conduct studies related to kinetics, inorganic synthesis or electrochemistry.
- Conduct studies related to the design of nuclear equipment.
- Investigate special guidance techniques, systems and devices.
- Develop mathematical analysis for various types of new rocket control systems.
- Conduct studies, analysis and tests of new materials and processes for possible use in advanced rockets.

Aerojet-General
CORPORATION
A Subsidiary of
The General Tire & Rubber Company
 PLANTS AT AZUSA
THE GENERAL AND NEAR SACRAMENTO,
CALIFORNIA

Write: Director of Scientific and Engineering Personnel, Box 296A3, Azusa, Calif. or Box 1947A3, Sacramento, Calif.

BOOKS

CALCULUS—A MODERN APPROACH

By Karl Menger

Reviewed by Helen Hassler,
General Electric Company

If one's hobby is diving into a complex tangle of symbols, equations, and curves, and trying to find some thread of continuity among them, then Karl Menger's *Calculus—A Modern Approach* is the book to get. If, on the other hand, you wish to get a basis in the theory and applications of calculus, this book might very well make you throw up your hands in desperation.

In the first place, Mr. Menger begins with a strange way of "clarifying" his concepts. Variable quantities, commonly denoted by the letters at the end of our alphabet, are split into several logical categories and a great effort is made to distinguish them from one another. Variables denoting the points on a line are printed in roman type, whereas simple curves are designated by numerals and letters in italics. Although these conventions are maintained consistently throughout the book, it is altogether too easy to confuse them. And who wants to keep referring back to page 4 to remind him of what the various sorts of type mean?

The traditional (and convenient) notation of such functions as $(D) \sin x$ and $\int \cos x dx$ are shortened into $D\sin$ and $\int \cos$. The purpose of such a notation is, in the author's words, to "... connect the functions themselves rather than their values . . ." These formulas are supposed to be "of algebraic beauty" and "streamlined". In this reviewer's opinion, they are merely irrelevant.

It is, to a large extent, a matter of preference and expediency whether one approaches calculus from a geometrical or an analytical standpoint. Menger chooses the geometrical. The first three chapters in this book are devoted to what he calls "the two basic problems of calculus", namely the area under a curve and the slope of a tangent to a curve. These two concepts are developed, with many side trips into the details and fine points, by means of numerical and graphical solutions, step lines, and a

great deal of meticulous examination of approximate solutions. In this way we are led to a suggestion of the possibility of derivatives and integrals.

In Chapter 4, the concepts of functions, variables, classes, etc., are discussed. This is done more in the spirit of logical symbolism than in the spirit of mathematics. Great stress is placed on the concept of class which, while most valuable and important in theory, can certainly consume a tremendous amount of time that might be spent in learning something about how to deal with derivatives and integrals and how to apply them.

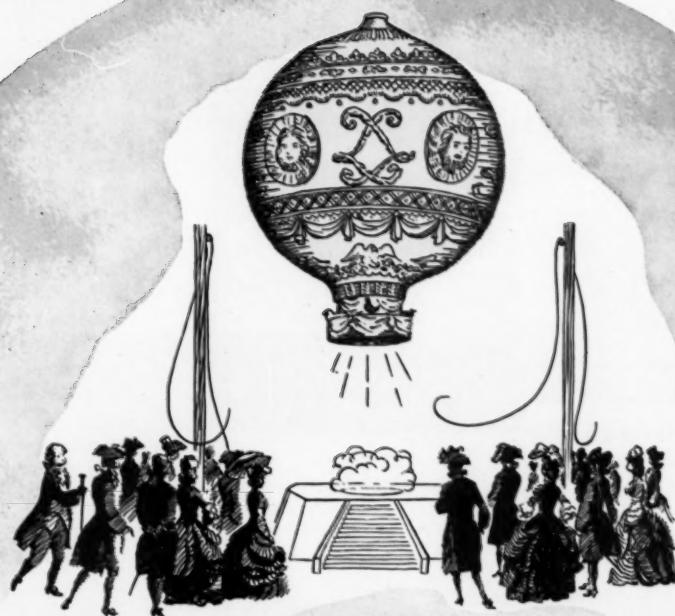
The same may be said about the chapter on limits. Surely such a thorough discussion of the interpretation and consequences of the definition of a limit belongs more to a theoretical study of the basis of calculus than to a supposedly elementary book on its operations.

It is not until Chapter 7 that we finally get to the application of calculus to science. And even here there is no really explicit demonstration of such application. Rather, there is a general explanation of the use of calculus in problems dealing with rates of change of motion, and a large amount of "interesting" sidelights on the consequences of the concepts involved.

The last two chapters are a hodge-podge of a lot of things that the author seems to feel should be included but didn't know where else to put them. They deal with, among other things, the mean value theorem, Taylor's expansion, maxima and minima, two place functions (representing surfaces), partial derivatives, etc. None of them are developed in a way which would enable the student to use them conveniently. Of the explanations: all of them, while undoubtedly extremely precise and thorough, take a great deal of time to wade through. One is left with the feeling that one had better spend a great deal more time thinking about them if he does not want to stay bogged down in detail. Indeed, this is the impression given by the entire book.

There is also an appendix consisting of a table of possible interpretations of x and y . It lists the various

(Continued on page 38)



Globe Aerostatique ... 1783

Montgolfier's vanguard project

A sheep, a duck, a rooster—the first payload carried aloft for atmospheric research. Louis XVI, his queen and his court, were astonished witnesses as Joseph Montgolfier's smoke-filled balloon rose in majesty 1500 feet over Versailles. The passengers? unharmed (except the rooster; kicked by the sheep).

Project Vanguard, 1957, is an equally momentous "first"—an attempt to place a 21-pound satellite in an orbit 300 miles up.

Aerojet-General, designer-builder of the famed Aerobee-Hi, will supply vital second-stage propulsion systems for Vanguard launchings during the International Geophysical Year.

Aerojet-General CORPORATION

A Subsidiary of
The General Tire & Rubber Company

THE
GENERAL
TIRE

PLANTS AT AZUSA AND
NEAR SACRAMENTO, CALIFORNIA

Aerojet-General invites scientists and engineers—men of imagination and vision—to join the attack on the most significant research, development and production problems of our time.

BOOKS

(Continued from page 34)

interpretations placed upon these symbols in terms of the operational definitions of algebra, analytic geometry, and calculus.

Referring to his appendix at the end of the book, the author states that "Unambiguous forms are listed [in this appendix] whose selection has been determined by one and only one factor—intelligibility." If this has been Mr. Menger's purpose in writing the book, he has admirably succeeded in illustrating the need for making his subject intelligible.
Ginn & Co. 354 pp.

include
Autom
ing, A
Tubes,
have b
point
dertak
cessful
of Ch
helpfu
in cor
mass C

ENGIN

McPHE
Reinho
Ave., 2

Rub
and m
gineer
longer
materi
produ
guishin
genera
of wi
with o
of thi
in his
and ha
than s
Natur
discus
and m
teriora
among

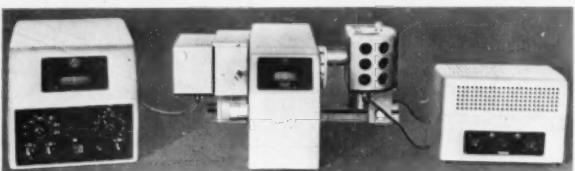
MATH

By STR
McGra
208 pp

One
its ed
the sp
what's
which
intent
author
h
Their
portur
relati
plied
use o
veys t
matic
method
that h
their
explai
binary
book t
exacti

MADE BY **CARL ZEISS** IN WEST GERMANY

SPECTROPHOTOMETER PMQ II



This new instrument offers universal applications for rapid, reliable and accurate photometric measurements of liquids, gases and solids at the highest resolving power of the spectrum.

The spectral region ranges from near-infrared (1,000 m μ) to far-ultraviolet (200 m μ). The transmission and extinction is directly and easily read off on the scale indicator. Operates on 110-volt Alternating Current.

Write for free, detailed literature

CARL ZEISS, INC., 485 FIFTH AVE., NEW YORK 17, N.Y.

Guaranteed uninterrupted repair service

FOR MORE INFORMATION CIRCLE 45 ON PAGE 48

... OF FURTHER INTEREST

SCIENTIFIC USES OF EARTH SATELLITES

J. A. VAN ALLEN, ED.

Univ. of Michigan Press, Ann Arbor, Mich. 316 pp, \$10.

This book makes available the thinking of leading scientists, technicians, and military experts, on the ways in which man-made satellites can contribute to our knowledge of the universe. Among the problems treated are the optical and visual tracking of satellites, instrumentation, meteorological measurements from the vehicle, and the possibilities of observing cosmic rays, auroral radiation, the earth's magnetic field, the ionosphere, and meteorites. The present volume is a compilation of 33 papers that were presented in January 1956 at the Upper Atmosphere Rocket Research Panel. Though descriptions of some experiments are outdated, the fundamental analytical thought is yet valid and valuable: and the book should prove a stimulating contribution to the literature.

ENCYCLOPEDIA OF CHEMISTRY

CLARK AND HAWLEY, EDs.

Rheinhold Publishing Corp., 430 Park Ave., NYC 22. 1006 pp + index, \$19.50.

This is probably the first attempt to combine the contributions of hundreds of authorities in the chemical fields into a single volume. The project is an enormous one because of the extreme diversity of the chemical fields and the great body of material contained in each. In addition to what are considered the usual technical subjects, the editors have undertaken to

The CARVER LABORATORY PRESS

... Solutions
for
Pressing
Problems

FOR DURAC-ACCURATE-SMALL SCALE TEST PRESS
THE CARVER LABORATORIES, INC.

Accurately controlled pressures to 20,000 lbs.; 6-inch gauge mounted on base. Carver Standard Accessories include Electric or Steam Hot Plates, Carver Test Cylinders, Swivel Bearing Plates, Cage Equipment. Available from stock. Write for catalog.

**FRED S. CARVER INC.
HYDRAULIC EQUIPMENT**

1 CHATHAM ROAD, SUMMIT, N. J.
FOR MORE INFORMATION CIRCLE 46 ON PAGE 48

include, also, fringe fields such as Automatic Process Control, Annealing, Abrasion Resistance, Electron Tubes, and Instrumentation. These have been treated from a "chemical point of view". This very sizable undertaking has been brought to a successful conclusion. The Encyclopedia of Chemistry should prove a very helpful book. It is certainly a big step in conveniently ordering our great mass of chemical knowledge.

ENGINEERING USES OF RUBBER

McPHERSON & KLEMIN, EDs.

Reinhold Publishing Corp., 430 Park Ave., NYC 22. 474 pp + index, \$12.50

Rubber is ready to take a larger and more important place among engineering materials. It should no longer be regarded as a specialized material for making tires and other products that require its most distinguishing properties, but rather as a general engineering material capable of wide applications in competition with other materials. The 16 chapters of this book, each written by an expert in his field, purport to tell the *why* and *how* of rubber and its uses rather than simply *what* it can be used for. Natural and synthetic rubbers are discussed; compounding, engineering and mechanical properties, design, deterioration, molecular structure, are among the other subjects treated.

MATHEMATICS AND COMPUTERS

By STIBBITZ AND LARIVIÈRE.

McGraw-Hill, 330 W. 42 St., NYC 36. 208 pp + index, \$5.00.

One of the ways in which R/E sees its editorial function is to bring to the specialist some understanding of what's going on in other fields in which he is not a specialist but, to all intents and purposes, a layman. The authors of Mathematics and Computers have heard a similar editorial call. Their book offers the reader an opportunity to get a better idea of the relationships between pure and applied mathematics and the growing use of automatic computers. It surveys the work of the applied mathematician, the problems he studies, his methods, and the computing devices that he uses. Computing devices and their components are described, and explanations of the binary system and binary codes are included. This is a book to satisfy the curious and the exacting.—LS

Multiple Unit

ORGANIC COMBUSTION FURNACES

- Complete Self-Contained Unit
- Positive Temperature Control to 1850° F.
- Hinged Type Construction

TYPE 123-T
Each Section Separately Controlled

This Organic Combustion Tube Furnace, made in three movable sections, is essential in the modern analytical laboratory.

This furnace can act as one or as three separate units. The use of tap-changing transformers allows closer temperature regulation and means savings in power and maintenance. The furnaces are hinged for easier operation. Write for Bulletin 735R.

HEVI DUTY ELECTRIC COMPANY

TRADE MARK
LABORATORY FURNACES **MULTIPLE UNIT** ELECTRIC EXCLUSIVELY
REG. U. S. PAT. OFF.

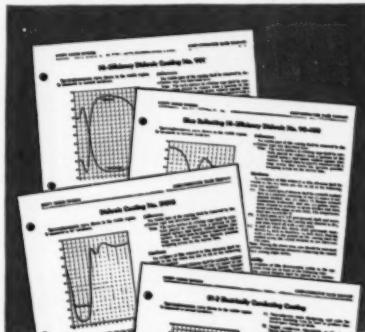
MILWAUKEE 1, WISCONSIN

FOR MORE INFORMATION CIRCLE 47 ON PAGE 48

Why not brief us
on your problems
involving special
COATINGS?

We manufacture many types of vacuum-deposited coatings . . . and we're both willing and prepared to work with you on your special problems. In fact, it is a key part of our business.

Whatever the nature or size of your problem, why not put it up to us?



Reference file on vacuum-deposited coatings. Data on reflection, transmission, adherence, hardness, durability, water resistance and other characteristics. Covers these coatings:

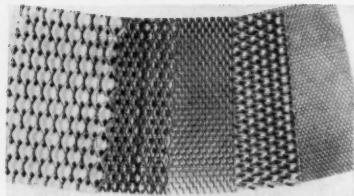
- Aluminum First Surface Mirrors
- Chromium First Surface Mirrors
- Gold First Surface Mirrors
- Neutral Filters
- Transparent Mirrors
- Beam Splitters, High Efficiency (low or no light absorption loss)
- Beam Splitting Dichroic Mirrors
- Beam Splitting Dichroic Filters
- Metallic Electrically Conducting Coatings
- Transparent Electrically Conducting Coatings
- Beam Splitters or Dichroic Mirrors (with transparent electrically conducting coatings)
- Low Reflection Coatings

WRITE FOR YOUR REFERENCE FILE

LIBERTY *vacuum-deposited* **COATINGS**
LIBERTY MIRROR DIVISION
LIBBEY·OWENS·FORD GLASS CO.
BRACKENRIDGE, PA.

FOR MORE INFORMATION CIRCLE 48 ON PAGE 48

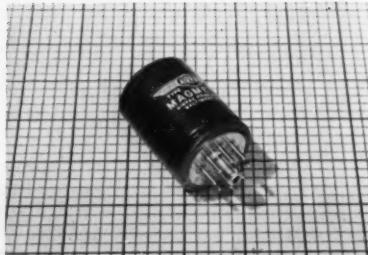
COMPONENTS



Ultra-Small Expanded Metal

Ultra-small expanded metal is now available with openings as small as 1/16". Micromesh in stronger, safer and more decorative and its uses, either standard or flattened, are unlimited. Diamond shapes at present are the basic pattern, but square and tear drop openings are in the development stage. It can be produced from aluminum, steel, stainless steel, copper, brass, monel or any standard sheet material. Designers Metal Corp., 503 E. 159th St., Harvey, Ill.

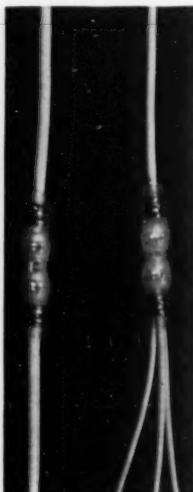
FOR MORE DATA CIRCLE 55 ON PAGE 48



Sub-Miniature Potentiometer

A new sub-miniature precision wire-wound potentiometer has precision jewel bearings that provide extremely low torque and also seal against abrasive dust or other foreign matter. They are highly accurate and dependable, and are ideal for sensitive instrument applications, and for servo, computer or selsyn use. Because of the extremely low torque required to rotate the shaft, no appreciable error is introduced, and therefore highest accuracy is maintained. Even though a highly precise component, it is very rugged. Ace Electronics Associates, Inc., 103 Dover St., Soverville 44, Mass.

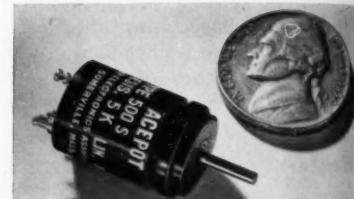
FOR MORE DATA CIRCLE 57 ON PAGE 48



Water-Sealed Splice

A new permanent, water-sealed and insulated splice has been developed. The splice accommodates AN wire sizes #26 thru #10 and is color-coded for easy size identification. Used as either a two-wire water-sealed splice, or for multi-wire applications, the Sealink meets military specifications. Composed of a highly conductive, electro-tinned copper link; a transparent nylon insulation sleeve; and anodized aluminum sealing rings. Burndy, Omaton Div., Norwalk, Conn.

FOR MORE DATA CIRCLE 56 ON PAGE 48



Frequency Detector

For telemetering, instrumentation and automatic control, a new detector provides an output current linearly proportional to frequency within the band from 375 to 425 cps. The output is suitable for operating a d'Arsonval indicating instrument, a servo type recorder, or a control circuit. Linearity is within 1% of midband frequency. Output is zero at low-frequency end of the band providing fail safe indication in absence of input. Airpax Products Co., Middle River, Baltimore 20, Md.

FOR MORE DATA CIRCLE 59 ON PAGE 48



Self-Seal Pipe Fitting

A thin, nut-like metal fitting promises to end leaky pipe connections. It seals instantly and permanently when threaded onto a standard pipe connection. Sealing is accomplished by a circular insert of Teflon plastic, resistant to temperature and chemically inert. Thus it can be used in lines carrying oil, water, gas, chemicals. The fitting holds its seal under ultimate pressures of 10,000 psi and temperatures from -200 degrees F to +500 F. Tru-Seal Division of Flick-Reedy Corp., Melrose Park, Ill.

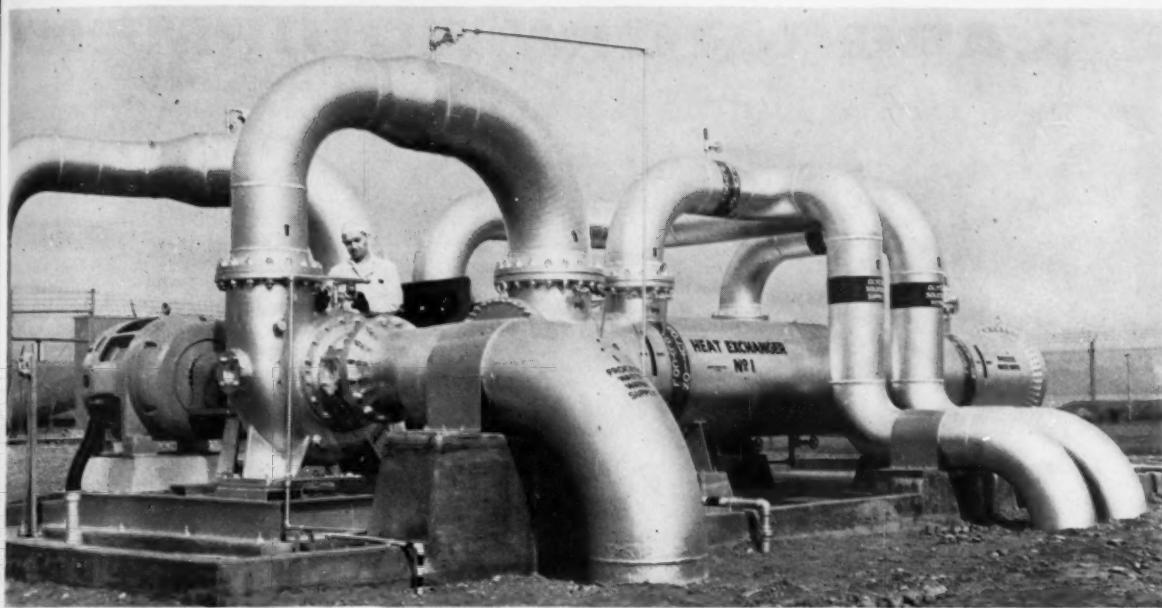
FOR MORE DATA CIRCLE 58 ON PAGE 48



Aluminum Manifold

A new cast aluminum manifold is designed to afford economical and efficient multiple mounting of 2, 3 or 4-way valves in any desired combination. Available in 2 and 3 station types, the manifold has full length inlet and exhaust ports, both 1" NPT, common to all valve stations. One access cover for all stations simplifies electrical wiring. Pilot solenoid leads are enclosed in dirt and moisture-proof flexible conduit. The manifold can be adapted to any type of control valve application. Combinations of single or double solenoid Speed King valves can be mounted at any station on the manifold. Valvair Corp., 454 Morgan Ave., Akron 11, Ohio.

FOR MORE DATA CIRCLE 60 ON PAGE 48



This heat exchanger transfers waste heat produced by atomic reactors to the space heating system for the production area at the A E C's Hanford Works.

THE OTHER SIDE OF THE ATOM

When the use of nuclear energy is urged as a supplement to fossil fuels, we usually think of electric power. Since 30 per cent of the energy consumed in the United States is for space heating, any extensive use of heat produced by reactor would certainly be an important factor in conserving our dwindling supplies of coal, oil and natural gas.

According to Albert J. Brayman, a Boston consulting engineer, the type of reactor needed to produce just heat is much simpler than those contemplated for power generation. Brayman, who is engaged in a sort of crusade for nuclear heat generation, also stressed that the efficiency of energy conversion of a heat reactor approaches 100 per cent compared to 30 per cent for the nuclear reactor turbine-generator combination.

Distribution Is Big Obstacle

The big obstacle to centralized nuclear heat generation is the distribution system: nuclear power plants can be tied into the existing electric utility systems; centralized nuclear space heating requires a pipe line system. Engineering an under- or overground pipe system is a small task compared to gaining the support of municipal authorities and the construction industry for the new system. Because of the distribution problem, centralized nuclear heating for cities might lag behind nuclear reactors for industrial heating. And the latter becomes even more attractive if the irradiation from the spent fuel elements can be used in the same plant for processing or catalytic action. (See "Gamma Radiation Facilities: Birth of a New Industry" in the June, 1956 R/E for a discussion of the use of spent fuel elements in gamma radiation processing in industry.)

Apparently the advantages of centralized nuclear heating outweigh the disadvantages for the Swedes. They have authorized five nuclear heating stations to be finished by 1968. One will heat their capital, Stockholm. Part of the power from one reactor will be used to generate electricity. Nuclear space heating is already practiced experimentally in Great Britain and the United States. The British started it all with a small job a few years back. Then the AEC's Hanford works built a nuclear space heating system using waste heat from their reactors. Brayman was one of the engineers who designed the Hanford system.

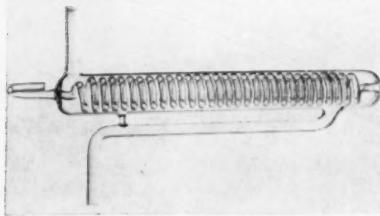
For equal thermal outputs, the heat reactor should cost no more than 50% of the cost of the power reactor, according to Brayman. Where the more plentiful and less costly materials can be used in the heat reactor, they are entirely unsuited for the power reactor. Temperatures and pressures are comparatively low, making heavy water, aluminum and graphite and other more common construction materials practical and feasible.

Five Years Away

How far away is centralized nuclear heating? Brayman predicts that the needed specialists in such work will not appear for five years. In the meanwhile, a breakthrough in breeder reactors would make the nuclear heat reactor even more attractive. Barring such a technical advance, Brayman believes that the AEC must encourage private industry to enter nuclear heating by reducing prices on fuel elements for reactors or by setting up demonstration nuclear heat reactors in the same spirit in which the demonstration atomic-powered merchant vessel will be built.

END

LABORATORY EQUIPMENT



Glass Trap

This all-glass trap is used where quantitative condensation is required in the vacuum manipulation of hydrocarbons and other volatile compounds. It can also be used as a vacuum system fore trap and as a collector in air pollution analyses. When it is immersed, coolant fills the inner spiral and surrounds the outer surface of the trap, providing 50% greater cold surface for condensation with the same external dimensions as conventional traps. California Scientific Glass Co., 35 S. Raymond Ave., Pasadena, Calif.

FOR MORE DATA CIRCLE 50 ON PAGE 48

Counter

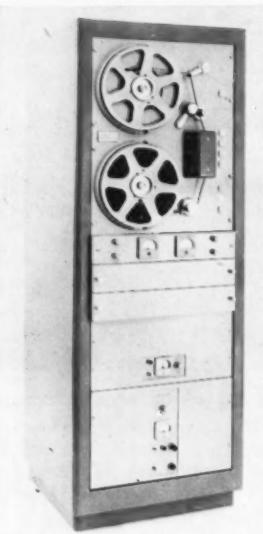
A portable electronic counter, weighing only seven pounds, combines plug-in electronic decade and five-digit mechanical register. Capable of counting rates up to 12,000 per minute, the counter meets lab counting needs which are beyond the speed of ordinary electro-mechanical devices, but which do not require the elaborateness of multi-decade electronic counters. Count capacity is 999,999 counts, with accuracy of plus or minus one count. Performance Measurement Co., 15301 W. McNichols Blvd., Detroit 35, Mich.

FOR MORE DATA CIRCLE 51 ON PAGE 48

Reproducer

A new table model printer which uses no stencils, inks or negatives, reproduces unlimited top quality dry copies up to 42" wide in seconds. The machine, called Ozaloid Streamliner 200, costs \$995, and is claimed to be the first large capacity model in the low priced field. General Aniline & Film Corp., Binghamton, N.Y.

FOR MORE DATA CIRCLE 52 ON PAGE 48



Tape Recorders

Modular electronic assemblies and tape transport design improvements for greater flexibility and accuracy are incorporated in a new line of instrumentation tape recorders. Up to seven tracks of data may be recorded at four speeds with the series FR 1100 equipment. Plug-in amplifiers allow for quick interchange to direct, fm and pulse width modulation recording. Heads are also compatible with all three modes, obviating head changes when switching from one method to another. Instrumentation Div., Ampex Corp., 934 Charter St., Redwood City, Calif.

FOR MORE DATA CIRCLE 53 ON PAGE 48

Area Monitor

A combination area-personnel-equipment monitor for detecting changes in radioactivity level has been introduced. Available with either beta-gamma sensitive GM probe, or with gamma sensitive scintillation probe, the unit incorporates a 3-cycle logarithmic count rate meter. The Nucligard plugs into any 110 volt outlet, and any desired warning level of radioactivity may be preset. When this level is exceeded, a visual and audible alarm is set in operation. Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind.

FOR MORE DATA CIRCLE 54 ON PAGE 48

Isolator Lab

A compact, medium priced isolation unit has been introduced for radiochemistry, metallurgy, toxic chemicals and similar applications. The Isolator/Lab has its own air supply, exhaust system and services, and is adjustable to meet any air demands. The unit can be used as either a closed or open system, singly or in any combination joined end to end for inert or special atmospheres with positive or negative pressures. It provides personal protection from hazardous materials and permits high-purity materials to be processed without contamination. Price of the set-up is \$1033. Fisher Scientific, 315 Fisher Bld., Pittsburgh 19, Pa.

FOR MORE DATA CIRCLE 61 ON PAGE 48



Vacuum Furnace

Cost, required space, maintenance and set-up time for vacuum processing are dramatically reduced with this new high vacuum lab furnace. Components are interchangeable, making the unit suitable for melting, annealing, brazing, sintering and degassing. Additional accessories and controls are optional, making the Hi-Vac F1212 furnace suitable for virtually every laboratory or light production requirement. High Vacuum Equipment Corp., 2 Churchill Rd., Hingham, Mass.

FOR MORE DATA CIRCLE 62 ON PAGE 48

Power
Developed
uses reg
microsec
high-cur
1-50 VD
switchin
maximum
able, wit
range. A
at 10 a
full load
load to
sen-Bar
FOR MO

Multip
Twenty
with tw
measure
weigh 75
bottles.
90°, Mo
The uni
tions, ru
ferent ty
etc. Lab
Chicago
FOR MO

Temp-
Having
a capaci
opening
has been
of produ
openings
connection
Additional
permit c
chamber
12411 W
Calif.
FOR MO

Vacuu
After e
vacuum
It can be
before a
faces Va
as a film
seal hea
as low a
When di
special t
the entir
to close
to achiev
ples on
Dept. P,
FOR MO

FEBR

Power Supply

Developed for transistor work and other uses requiring excellent regulation and microsecond response, is a low-voltage, high-current power supply. Output is 0-50 VDC continuously variable without switching. Current range is 0-1000 Ma maximum. Full output current is available, without derating, throughout entire range. A second output supplies 6.3 VAC at 10 amps. Recovery time from 0 to full load is 0.5 millisecond; from full load to removal, 0.25 millisecond. Dresser-Barnes Corp., 250 N. Vinedo Ave., Pasadena, Calif.

FOR MORE DATA CIRCLE 63 ON PAGE 48

Multiple Test Unit

Twenty tests can be run simultaneously with two new rotator oscillators. They measure 49" long x 10" wide x 14" high, weigh 75 lb. and hold twenty 32oz square bottles. Model 5300 oscillates through 90°, Model 5301 rotates through 360°. The units can be used for mixing solutions, running corrosion tests with different types and quantities of inhibitors, etc. Labline, Inc., 3070-82 W. Grand Ave., Chicago 22, Ill.

FOR MORE DATA CIRCLE 64 ON PAGE 48

Temp-Test Chamber

Having a range of -65°F to 600°F, and a capacity of 600 cubic inches of working space, a new temperature chamber has been developed for ambient testing of products. Test trays are provided with openings for electrical or mechanical connections to the products under test. Additional test trays are available to permit continuous operation of the test chamber. Stratham Development Corp., 12411 W. Olympic Blvd., Los Angeles 64, Calif.

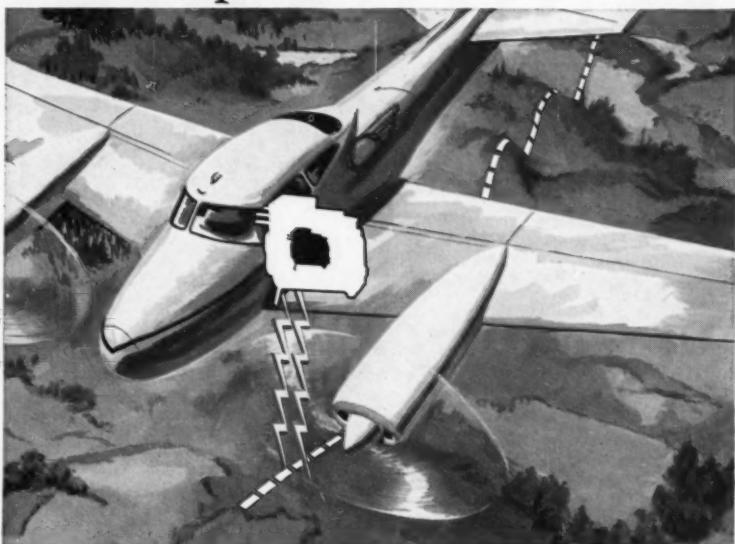
FOR MORE DATA CIRCLE 65 ON PAGE 48

Vacuum Pump Sealer

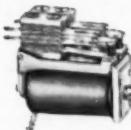
After extensive field testing, a new vacuum pump sealer has been released. It can be brushed on the heads of pumps before assembly. On metal-to-metal surfaces Vacuum Pump Sealer #2092 acts as a film-like gasket, and will effectively seal heads of pumps which pump down as low as 1/10 micron vacuum pressure. When diluted to spray viscosity with a special thinner, it may be used to coat the entire outside surface of the pump, to close microscopic pores in the casting, to achieve lowest possible vacuum. Samples on request. Paule Chemical Corp., Dept. P, Charleston 29, Mass.

FOR MORE DATA CIRCLE 66 ON PAGE 48

Potter & Brumfield engineering is in this picture



**Which P&B relay did Television Associates specify
FOR THEIR AIRBORNE COMPUTER?**



MH Series



MB Series



MC Series

Surveys for pipe lines, electric transmission routes and microwave paths are now made from the air, by radar. Television Associates of Indiana, Inc. developed this speedy new technique—and the equipment—which provides clients with detailed profiles of the terrain to be crossed.

Part of the equipment, an intricate airborne computer, requires relays that are fast-acting, light weight, versatile. They must have high shock and vibration resistance and remain operative in temperatures ranging from -45°C to +85°C.

Modified MH relays by P&B were specified. These miniature relays meet all Television Associates' requirements and provide high reliability in a mighty small package. Challenging relay problems are solved daily at P&B. Twenty-five years of creative engineering are behind every P&B relay. Write today for our new catalog.

ENGINEERING DATA

SERIES: MN Miniature Telephone.

CONTACTS: Up to 18 springs, maximum 9 in each stack, forms A, B, C, D, E, X and Y. AC relays are limited to a maximum of 2 poles. Various contact material available.

VOLTAGE RANGE: DC - .05 to 110 V.—AC - 6 to 230 V. 60 cycle.

COIL RESISTANCE: 22,000 ohms maximum.

TEMPERATURE RANGE: High temperature range (DC) -55°C. to +135°C. Standard DC -55°C. to +85°C. Standard AC -45°C. to +40°C. Other temperature ranges available to specification.

TERMINALS: Standard pierced solder lug holes will take (2) No. 18 hook-up wires. Adaptable for printed circuits.

ENCLOSURES: Dust cover plus wide range of hermetically sealed covers and types of terminations.

DIMENSIONS: 1-9/16" L x 25/32" W x 1-3/8" H. (4c Relay).

**P&B RELAYS AVAILABLE AT MORE THAN
500 DISTRIBUTORS IN ALL PRINCIPAL CITIES**

Potter & Brumfield, inc.

PRINCETON, INDIANA Subsidiary of AMERICAN MACHINE & FOUNDRY COMPANY

Manufacturing Divisions also in Franklin, Ky. and Laconia, N. H.

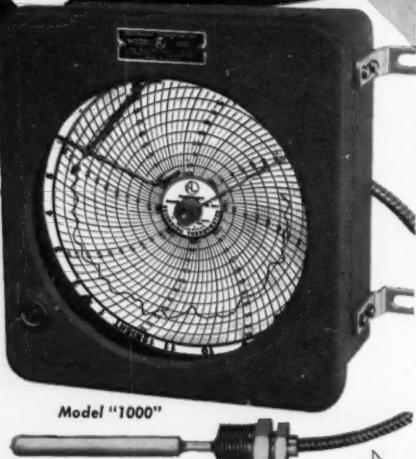
FOR MORE INFORMATION CIRCLE 67 ON PAGE 48

AUTO-LITE

TEMPERATURE RECORDING...

Newly designed, Model "1000" Auto-Lite Recorder gives permanent proof of temperature behavior. • 6" clear reading chart; various standard ranges from minus 40°F. to plus 550°F. • 3 standard types; choice of 24-hr. or 7-day cycle. • Electric or mechanical chart drive. • With capillary tubing for remote reading. Priced from \$49.50.

Send for new catalog describing many styles of Auto-Lite temperature Recorders and Indicators.



Model "1000"

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
TOLEDO 1, OHIO

NEW YORK • CHICAGO • SARNIA, ONTARIO

TEMPERATURE RECORDERS

FOR MORE INFORMATION CIRCLE 68 ON PAGE 48

management affairs

Six of the most popular articles for improving technical management published in RESEARCH & ENGINEERING in recent months have been reprinted, including four by Luis J. A. Villalon, our Management Affairs Editor. Available for 25¢ each, they are listed below.

- LIMIT THEOREMS: Practical Tool for Project Evaluation
- THE DIFFICULT PERSONALITY PROBLEM IN R & D
- EXECUTIVE HEALTH: 14 Ways to Maintain It
- HOW'S YOUR STAFF EFFICIENCY?
- HOW'S YOUR ORGANIZATION QUOTIENT?
- TIME MANAGEMENT FOR THE R & D EXECUTIVE

Reprints of the above articles on management problems are available for twenty-five cents each. Send check or money order to RESEARCH & ENGINEERING, 77 South St., Stamford, Conn.

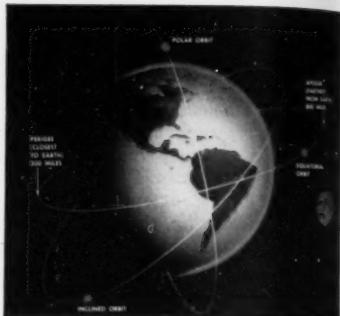


Illustration courtesy of Popular Science Monthly.

New stability for satellite tracker

Power resistors win out over "precision" resistors for low drift plus high overload capacity

A few millivolts power-supply drift can mean a large range or angle error in tracking the U. S. Navy's satellite missile—built for the International Geophysical Year.

It's for this reason that voltage regulated power supplies for the tracking equipment must be as stable and as drift-free as the state of the art permits, over very wide range of operating conditions.

That, in brief, is the problem that faced engineers at Power Designs Inc., Richmond Hill, N. Y., builders of regulated power supplies for the satellite tracking equipment.

To make the problem really tough, however, maximum reliability required that failure of any component not damage any other component. Certain vacuum tube failures, for example, subjected ordinary precision resistors to an 8 to 10 times overload. The resistors charred, opened up. Some even blew up, literally!

Engineers at Power Designs got together with Ward Leonard engineers and came up with the answer: A special Ward Leonard Vitrohm resistor that had all the drift-free stability required plus the overload capacity that makes Vitrohm resistors a favorite among designers. More economical, too.

This, of course, is added testimony to the facts we've known all along about Ward Leonard Vitrohm resistors. And, it shows the cooperation you can expect when you bring your special problems to Ward Leonard's application department.

We predict, too, that you'll be hearing more about these special high-stability Ward Leonard Vitrohm resistors. Particularly if you're concerned with analog or digital computers, acquisition or tracking equipment, instrumentation or other application requiring the utmost in stability plus high overload insurance. For more data now write: Ward Leonard Electric Co., 12 South Street, Mount Vernon, N. Y. (In Canada: Ward Leonard of Canada Ltd., Toronto.)

LIVE BETTER...Electrically

FOR MORE INFORMATION CIRCLE 70
ON PAGE 48

MATERIALS

Fuel or Catalyst

A soda-based process is being used to produce trimethyl aluminum in pilot plant quantities. A highly flammable liquid which ignites spontaneously in air, this compound is being tested as a fuel and ignitor for ram jet and turbo jet engines. It also has possibilities as a polymerization catalyst and as an intermediate for chemical synthesis. Also available from the pilot plant is methyl aluminum sesquichloride, which may find use in similar applications. Cost estimates indicate that trimethyl can be produced in commercial quantities for \$2 to \$5 lb. U.S. Industrial Chemicals Co. Div., National Distillers Products Corp., 99 Park Ave., New York 16, N.Y.

FOR MORE DATA CIRCLE 71 ON PAGE 48

Potassium Silicate

Potassium silicate in two commercial grades is now available. Potassium silicate No. 28 is recommended as an adhesive and binder for welding rod and other coatings, and for special cements. Potassium silicate No. 40, more alkaline than No. 28, is suggested for the same applications, as well as a builder for potash soaps and for rapid sudsing liquid soaps and detergents. Other ratios and concentrations, including lump or ground glass can be had on request. Cowles Chemical Co., 7016 Euclid Ave., Cleveland 3, Ohio.

FOR MORE DATA CIRCLE 74 ON PAGE 48

Extra Pure Cadmium

Extra-high purity cadmium metal sticks are now being produced for analytical chemists and researchers. These are Certified reagent grade, with individual lot analysis. The reagent has only 0.001% iron, 0.005% copper, 0.17% lead and 0.05% zinc. Costs about \$8 per lb. Fisher Scientific, 315 Fisher Bldg., Pittsburgh 17, Pa.

FOR MORE DATA CIRCLE 75 ON PAGE 48

Ceramic Fuel Elements

Fuel elements for atomic reactors are being molded of uranium oxide. The demand for materials to withstand increasingly higher temperatures would seem to indicate the use of ceramics to replace metals. Once these elements become normal production items, it is believed that they will be less expensive than metal elements. The reprocessing of used ceramic elements is also expected to be easier. The Norton Co., Worcester 6, Mass.

FOR MORE DATA CIRCLE 76 ON PAGE 48

Bar Steel

With a unique combination of physical and mechanical properties, bar steel is produced by a new process called Elevated Temperature Drawing. The dimensional tolerances, surface finish and excellent machineability generally associated with cold finished bars have been incorporated into a bar product which also has strength properties normally developed by heat treatment. (Heat treatment here is meant to describe the standard quench and temper cycle for hardening steel.) Further, it eliminates the need for heat treating and attendant operations in many instances. LaSalle Steel Co., Box 6800-A, Chicago 80, Ill.

FOR MORE DATA CIRCLE 72 ON PAGE 48

Tubular Heater Seal

Formed of a special plastic resin in conjunction with a ceramic bead, a new tubular heater seal has successfully undergone a variety of tests. A shoulder on the bead controls creepage distance from shoulder to sheath without adding to the dimensions of the heater. The seal will operate at 90°F with 90% humidity, giving protection against moisture and fumes. Recommended for economical application where leakage current characteristics do not exceed 200 microamperes, it is available on all sizes of tubular heaters for temperatures up to 300°F. General Electric Co., Schenectady 19, N.Y.

FOR MORE DATA CIRCLE 73 ON PAGE 48

Copper Plated Wire

Communications wire having a high strength steel core with a heavy copper coating is now in limited commercial production. The copper is joined to the steel in a permanent bond that permits twisting, bending or flattening the wire without breaking the bond. In addition to costing less than solid copper, the new wire has the reinforcing strength of a steel core. It will meet the multiple requirements of high tensile strength (up to 250,000 psi), electrical conductivity and resistance to fatigue and corrosion. Coppery wire is produced in two grades, with 30 and 40 percent conductivity, in both high and extra high strength classes, and in all standard sizes from #1 to #12 AWG. National-Standard Co., Niles, Mich.

FOR MORE DATA CIRCLE 78 ON PAGE 48

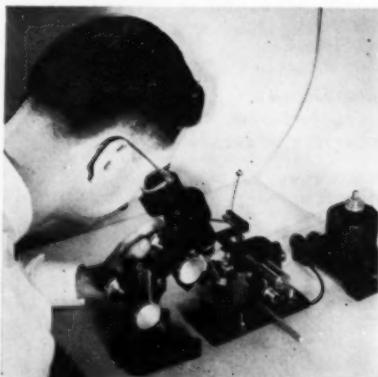
Minuscule "Detective"

Tiny foreign bodies as small as 3 to 5 mils in diameter, called inclusions, have long plagued metallurgists in developing alloys. Using an instrument with a power-operated drill only one mil in diameter, technicians in the Materials Engineering department at Westinghouse Electric Corp., Pittsburgh, Pa., are now able to remove samples of the inclusion for analysis. This is done on an emission spectrograph, a method which burns the sample under high voltage, releasing radiation characteristics of the elements present. These are recorded on film, where they can be later picked off and converted into percentages of certain elements.

Zinc-Clad Aluminum

Long in the research and development stage, zinc-clad aluminum alloy can now be had in commercial quantities. The soldering sheet is expected to open the door to many aluminum applications as yet untried, since it brings aluminum into the solderability range of copper. Used with specially developed soldering techniques, zinc-clad aluminum will simplify maintenance and repair of soldered assemblies, as well as reduce costs of production. The sheet is made with one or both sides clad. Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh 19, Pa.

FOR MORE DATA CIRCLE 77 ON PAGE 48



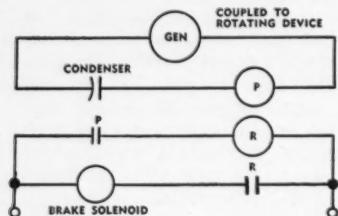


ultra-sensitive relays

HELPFUL DATA FOR YOUR CIRCUITRY IDEA FILE...

(No. 3 in a series by Barber-Colman Company)

The circuit drawing below indicates just one of the hundreds of ways many manufacturers are utilizing Barber-Colman Micropositioner ultra-sensitive relays to solve complex control problems. Could this be the answer to some of yours, too?

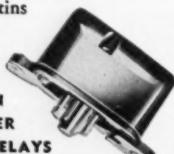


ACCELERATION CONTROL

The circuit shown above provides an acceleration control to prevent skidding of aircraft, truck, or bus wheels when brakes are applied. Similar Micropositioner circuits can also be designed for many applications where limited acceleration or deceleration is important.

In these circuits a Barber-Colman Micropositioner is connected in series with a condenser across the output of a Barber-Colman permanent magnet d-c generator coupled to the rotating wheel. When the generator velocity is constant (acceleration zero), no voltage appears across the Micropositioner coil. A change in velocity produces a coil input proportional to the acceleration. Polarity of input depends on whether the velocity is increasing or decreasing. When the input is large enough to close the Micropositioner contacts, P, a secondary relay, R, operates the solenoid in the braking circuit.

If your projects involve control of acceleration, why not make a test with a Micropositioner engineered for circuits similar to that shown above? Write for technical bulletins F-7279 and F-3961-6.



**BARBER-COLMAN
MICROPOSITIONER
POLARIZED DC RELAYS**

Various types... plug-in, solder-lug, screw terminal, hermetically sealed. Operate on input powers of 50 to 1,000 microwatts for use in photoelectric circuits, resistance bridge circuits, and electronic plate circuits. Send for data.

BARBER-COLMAN COMPANY
Dept. N, 1874 Rock Street, Rockford, Illinois

FOR MORE DATA CIRCLE 80 ON PAGE 48

Advertising Index

AEROJET-GENERAL CORP.	36, 37
Agency—D'Arcy Advertising Co.	
B & H INSTRUMENT CO.	18
Agency—The Kotula Co.	
BAKER & ADAMSON, GENERAL CHEMICAL DIV., ALLIED CHEMICAL & DYE CORP.	23
Agency—Atherton & Currier, Inc.	
BARBER-COLMAN CO.	46
Agency—Howard H. Monk & Associates	
THE BRISTOL Co.	33
Agency—James Thomas Chirurg Co.	
BURNDY CORP.	Cover IV
Agency—The Wexton Co., Inc.	
THE CALIDYNE COMPANY	32
Agency—Meissner & Company, Inc.	
THE CARBORUNDUM CO.	5
Agency—G. M. Basford Co.	
FRED S. CARVER, INC.	38
Agency—J. C. Bull, Inc.	
CENTRAL SCIENTIFIC COMPANY	31
Agency—Marsteller, Rickard, Gebhardt & Reed, Inc.	
COATING PRODUCTS	17
Agency—Hoffman-Manning Inc.	
COMMERCIAL SOLVENTS CORP.	4
Agency—Fuller & Smith & Ross, Inc.	
CONSOLIDATED ELECTRODY-NAMICS CORP.	6
Agency—Charles L. Rumrill & Co., Inc.	
THE ELECTRIC AUTO-LITE CO. INDUSTRIAL THERMOMETER DIV.	44
Agency—J. C. Bull, Inc.	
FAIRCHILD CAMERA AND INSTRUMENT, INC.	7
Agency—G. M. Basford Co.	
FISHER SCIENTIFIC CO.	33
Agency—Smith, Taylor & Jenkins, Inc.	
HEVI DUTY ELECTRIC CO.	39
Agency—Camm Costigan, Inc.	

ACOUSTICAL ENGINEER:

Satisfy
Your Creative
ability...

at
RCA

RCA needs an acoustical engineer for design and development work on devices and systems in military and commercial fields: microphones, head-sets and loudspeakers; noise and vibration measurement and analysis; speech compression systems; noise cancellation microphones; psychoacoustics. RCA—pioneer in acoustics—has facilities perfect for the man who desires advanced work.

FOR CONFIDENTIAL

INTERVIEW

Call Collect—Mr. R. A. Wallace
At Camden, N. J.
WOodlawn 4-7800
Or, send resume to:
Mr. John R. Weld
Employment Mgr., Dept. Z-88
Radio Corporation of America
Camden 2, N. J.



**RADIO
CORPORATION
OF AMERICA**

KINNEY MFG. DIV., THE NEW YORK AIR BRAKE CO. . .	19
Agency—Humbert & Jones, Inc.	
LIBBEY-OWENS-FORD GLASS CO.	39
Agency—Fuller & Smith & Ross, Inc.	
ARTHUR D. LITTLE, INC.	15
Agency—Larcom Randall Advertising	
PEERLESS ELECTRICAL PRODUCTS DIV., ALTEC LANSING CORP.	34
Agency—Dan B. Miner Co., Inc.	
POTTER & BRUMFIELD MFG. CO., INC.	43
Agency—Fletcher D. Richards, Inc.	
RADIO CORP. OF AMERICA	46
Agency—Al Paul Lefton, Inc.	
RELYEA PUBLISHING CORP.	24, 25
Agency—Direct	
A. O. SMITH CORPORATION	Cover II
Agency—Klau-Van Pietersom-Dunlap, Inc.	
TEKTRONIX, INC.	2, 47
Agency—Hugh Dwight Advertising	
UNION CARBIDE & CARBON CORP.	Cover III
Agency—J. M. Mathes, Inc.	
WARD LEONARD ELECTRIC CO.	44
Agency—James Thomas Chirurg Co.	
CARL ZEISS, INC.	38
Direct	

advertising offices

NEW YORK CITY—Alfred Malecki, 103 Park Ave., New York 17, N.Y., Lexington 2-0541

NEW ENGLAND & NEW YORK STATE—Victor Raiser, 103 Park Ave., New York 17, N.Y., Lexington 2-0541

CLEVELAND—Fred Grant, 11820 Edgewater Drive, Cleveland 7, Ohio, ACademy 1-6858

CHICAGO—R. Jerome Claussen, Rm. 534, 52 W. Jackson Blvd., Chicago 4, Ill. WAbash 2-7838

LOS ANGELES—Wilbur Menne, Jack Follansbee, Arden Parkes, The Menne Co., 1127 Wilshire Blvd., Los Angeles 7, Calif., MUtual 4191

SAN FRANCISCO—Robert Zunich, The Menne Co., 714 Sansome St., San Francisco 4, Calif. GArfield 1-3846

Your Tektronix Field Engineer as an

OPERATIONAL AID

Clearing up operational difficulties is another of his many helpful functions.



TOO MANY KNOBS?

Not at all! Rather, an extremely versatile instrument. Tektronix high-performance oscilloscopes are capable of so many applications that their full potential is not always realized by the operator. Although he will use only a few in any one application, many knobs are required to give the operator full control of the many oscilloscope functions. Perhaps all these controls will seem unnecessary and confusing at first, but you'll be glad they're there when you find out how useful your Tektronix Oscilloscope can be. So if you are slightly confused by the controls of your new oscilloscope, call in your Tektronix Field Engineer. By demonstrating their use in various applications, he'll help you become more proficient, and you'll be well on your way to enjoying all the usefulness built into your instrument.

GROUP INSTRUCTION

When a Tektronix Oscilloscope is to be used by several engineers, or several new oscilloscopes are received at about the same time, your Tektronix Field Engineer will be happy to conduct an informal class on operation. Try to time his class for as soon after delivery as possible, and include in the group all those who are to use the instrument. This will insure your getting maximum usefulness from the oscilloscope ... right from the start.



POST-GRADUATE REVIEW

Even if you know your Tektronix Oscilloscope quite well, a few moments spent going over the controls and their functions with your Field Engineer can pay off. He wants to be certain that you are getting the fullest usefulness with the least effort. Next time he visits you, make sure you are operating your instrument the easy way in all your applications.



Tektronix Field Offices: Albuquerque, N. M.—Baltimore, Md.—Bronxville, N. Y.—Cleveland, Ohio—Dayton, Ohio—Elmwood Park, Ill.—Los Angeles, Calif.—Menlo Park, Calif.—Minneapolis, Minn.—Newtonville, Mass.—Philadelphia, Pa.—Phoenix, Ariz.—Syracuse, N. Y.—Union, N. J.—Willowdale, Toronto, Ontario.

Tektronix Engineering Representatives: Bivins & Caldwell, High Point, N. C. and Atlanta, Ga.—Hawthorne Electronics, Portland, Ore. and Seattle, Wn.—Hytronics Measurement Associates, Denver, Colo.—Arthur Lynch & Associates, Fort Myers, Fla.

Tektronix is represented in twenty overseas cities by qualified engineering organizations.



TEKTRONIX, INC., P. O. BOX 831, PORTLAND 7, ORE.

FOR MORE INFORMATION CIRCLE 41 ON PAGE 48

HERE'S A BRIEF REVIEW OF LAST MONTH'S PRODUCT ADS FOR YOUR INFORMATION.

Photosensitive Tubes

83

These devices have numerous applications in science and industry such as: closed circuit TV for training and inspection, electronic measurement, atomic particle research and control of machinery.

Radio Corp. of America, Sec. A84Q,
Commercial Engineering, Harrison, N.J.

Liquid Fluorine

84

As a result of research, fluorine can now be transported and handled directly as a liquid, in tank truck tonnages.

Product Development Dept., General Chemical Division, Allied Chemical & Dye Corp., 40 Rector St., New York 6, N.Y.

Ultrasonic Systems

85

This firm has a large staff of theoreticians and engineers to help solve problems for all industries. Bulletins are offered on various applications.

Acoustica Associates
Glenwood Landing, L.I., N.Y.

Instrument Service

86

Lending a hand with maintenance problems and instruction in maintenance techniques for its oscilloscopes, are among the many services rendered by this firm's staff of engineers.

Tektronix, Inc. P.O.Box 831, Portland, Ore.

Contract Research

87

This company offers separate contract services covering all types of applied research in process and product engineering in the chemical and petroleum fields.

Research Div., The Fluor Corp., Ltd.
12012 E. Washington Blvd., Whittier, Calif.

Fuel for Thought

88

The fuel propellant of the future may prove to be an inorganometallic. Lithium combines low density with high heat of combustion to give a ratio of extraordinary chemical energy per unit of weight.

Lithium Corp. of America, 2692 Rand Tower,
Minneapolis, Minn.

Permanent Magnets

89

Location of permanent magnets in a magnetic circuit is a design factor. A paper entitled "An Experiment in Magnet Location" is offered by this organization.

Indiana Steel Products Co.,
Valparaiso, Indiana

Paradoxical Lithium

90

Classed originally as an alkali, Lithium has emerged as a metal with such uses as: catalyst, heat transfer medium, metallic scavenger, high-temperature fuel and a thermonuclear material. Technical data bulletin is available.

Foote Mineral Co., 455 Eighteen West
Chelten Bldg., Philadelphia 44, Pa.

High Heat Conductivity

91

Silicon carbide refractories offer roughly 11 times the conductivity of fire clay. They are ideal for applications where exceptional resistance to direct flame is needed.

Refractories Div., Dept S17,
The Carborundum Co., Perth Amboy, N.J.

Rare Earths

92

Elements 57 through 71 in the form of chemical salts are produced individually or in combinations for varied uses throughout industry.

Lindsay Chemical Co.,
274 Ann St., West Chicago, Ill.

Titrimeters

93

This family of instruments for quality control includes five different types: standard, automatic, high-frequency, amperometric and coulometric.

Fisher Scientific, 115 Fisher Bldg.,
Pittsburgh 19, Pa.

How to Get Things Done

94

This visual control system gives a picture of your operations at a glance. It is recommended for scheduling R/D projects. Booklet on request.

Graphic Systems, 55 W. 42 St., N.Y. 36, N.Y.

Ceramic Ware

95

Zirconia ware features extremely high melting point, chemical inertness and insulating qualities. Typical applications are crucibles and tubes for high-temperature processes.

Laboratory Equipment Corp.,
5001 Hilltop Rd., St. Joseph, Mich.

Solve Pump Problems

96

These pumps constructed without stuffing box or shaft seals, eliminate packing problems in handling corrosive liquids.

Vanton Pump & Equipment Corp.,
Dept RE-1, Hillside, N.J.

Special Charts

97

Precision instrument charts in strip or circular form can be printed to your specifications. Special papers and sizes are available.

Bristol Co., Waterbury 20, Conn.

Compressor

98

This laboratory-scale gas compressor is known for top performance. It features horizontal multistage construction with only one stuffing box, metal packing and sight bubble indicator.

Autoclave Engineers,
2934 W. 22nd St., Erie, Pa.

ADDITIONAL INFORMATION FORM

CLIP OUT AND MAIL TO:

RESEARCH & ENGINEERING
103 PARK AVENUE
NEW YORK 17, N.Y.

PLEASE TYPE OR PRINT

Name

Title

Company

Company Address

Zone No.

PLEASE USE THIS FORM BEFORE MARCH 1.

FOR MORE INFORMATION ON PRODUCTS OR ADS
IN THIS ISSUE, CIRCLE APPROPRIATE NUMBER.

1	11	21	31	41	51	61	71	81	91
2	12	22	32	42	52	62	72	82	92
3	13	23	33	43	53	63	73	83	93
4	14	24	34	44	54	64	74	84	94
5	15	25	35	45	55	65	75	85	95
6	16	26	36	46	56	66	76	86	96
7	17	27	37	47	57	67	77	87	97
8	18	28	38	48	58	68	78	88	98
9	19	29	39	49	59	69	79	89	99
10	20	30	40	50	60	70	80	90	100

93
quality
types:
nency,

94
a pic-
ce. It
R/D

95
high
and
tions
-tem-

96
stuff-
cking
quids.

97
p or
your
sizes

98
or is
ures
with
and